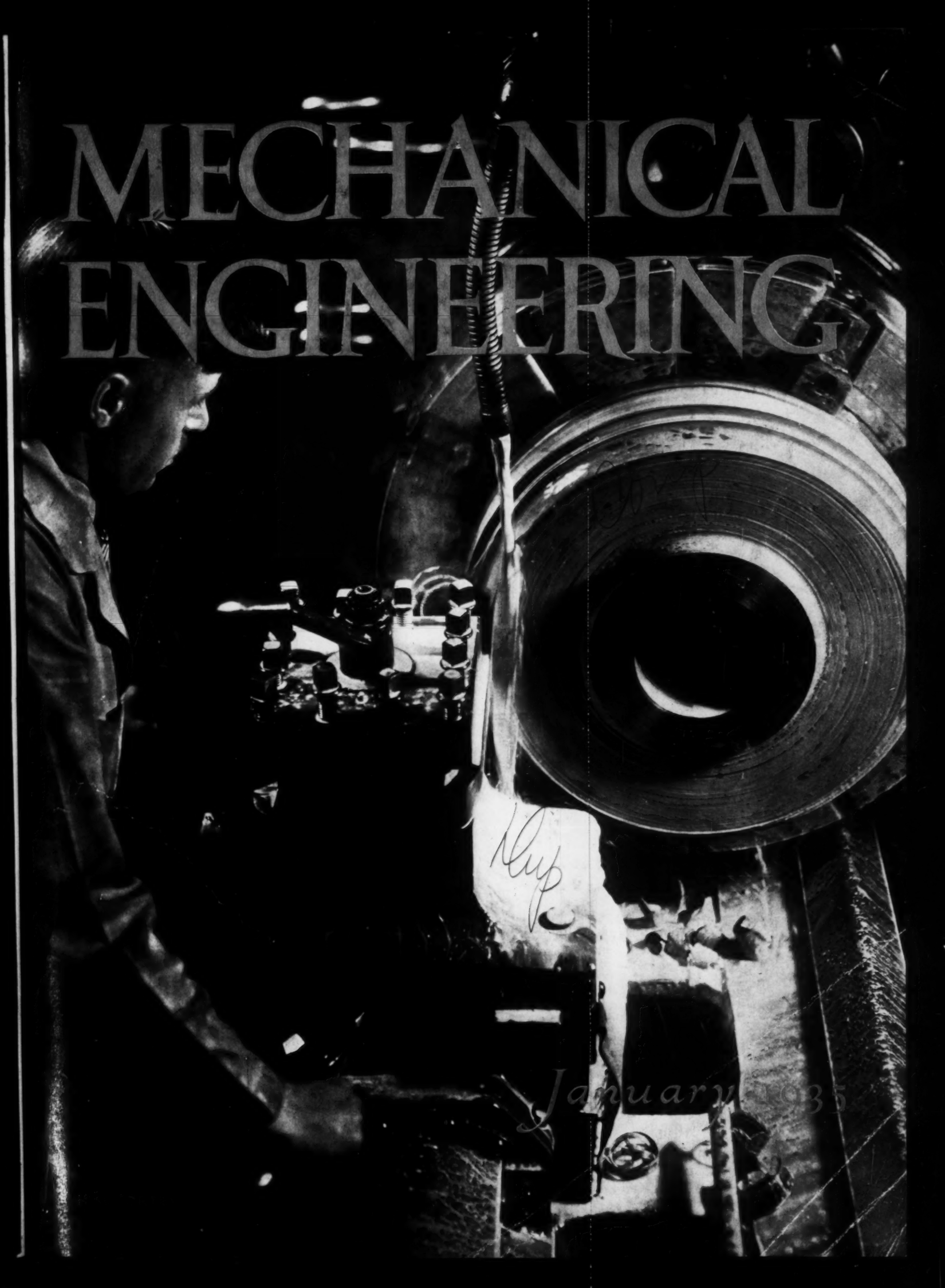
MECHANICAL ENGINEERING



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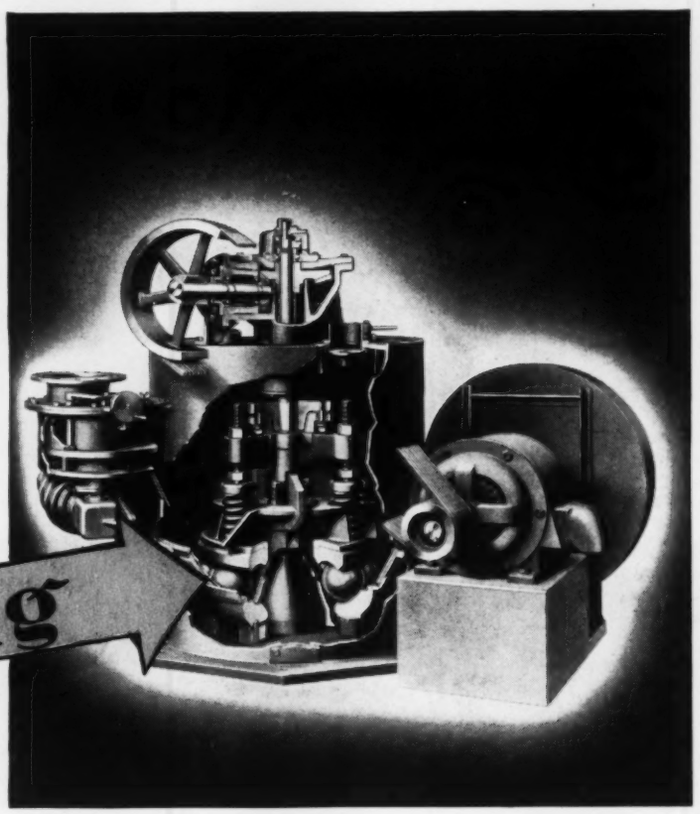

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MECHANICAL ENGINEERING

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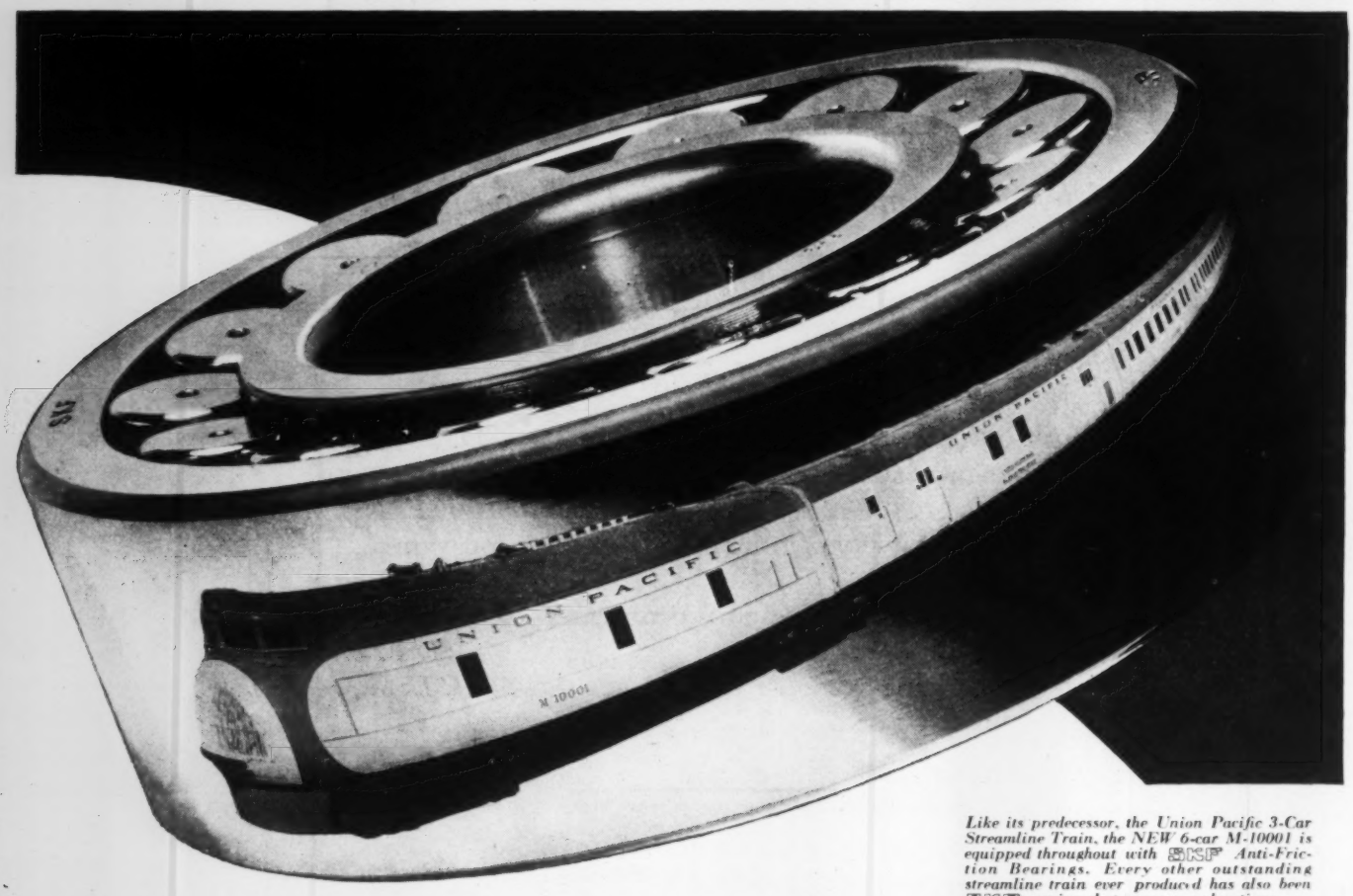

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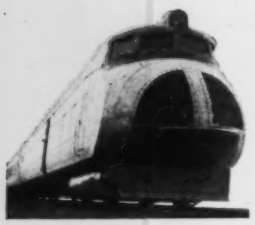

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VOLUME 57
No. 1

MECHANICAL ENGINEERING

JANUARY
1935

GEORGE A. STETSON, *Editor*

Gentlemen—The New Secretary!

HE WAS leaning heavily on the table, supported by one elbow, and drawing furiously on the stubby pipe clutched in his right hand, his face distorted with those scowls and wrinkles that betoken the birth pains of a new thought. Then suddenly the hand that held the pipe shot out to beat an irregular tempo of emphasis for his remarks and this recent listener and thinker put new life into the discussion that had been going on in the committee with which he was sitting, deftly crystallizing the ideas and suggesting a practicable solution to the problem.

This was our first meeting with C. E. Davies, nearly fifteen years ago. "There must be something to this young man," we thought, for the older men with whom he sat, some of whom had been interested in the Society's work before he was born, seemed to like his frank assumption of leadership and to respect his ideas. And there *was* something to him, as this observer came later to know, for these men and their fellow engineers saw fit to entrust him with the administration of the Society's affairs and more recently to appoint him Secretary.

Year after year, in one form or another, this incident of the committee room has been repeated, and new evidence accumulates of the fertility of ideas and qualities of leadership that distinguish the new secretary. Elsewhere in this issue a brief summary of his career and connections will be found. The purpose of this comment is to bring to those who may not know him a few words of appreciation from one who has known him and worked with him. And because the policy of this Society provides freedom of expression to its editor, no secretarial censorship will intervene to add to or to detract from this tribute.

Those who are close to the Society's work know what rich talents Davies possesses. They have seen him in action. They are familiar with that quality of his personality that makes him fearful lest he fall prey to his own prejudices and the traditional thinking of his professional colleagues, that restlessness of spirit and mind that prods him out of comfortable grooves and drives him to do things that it would be easy to neglect. They appreciate that quality of his mind that "clicks" so unerringly when propositions are put up to him; that makes him aware of what is wanted before the request is fully expressed by the solicitor; that enables him to get down to fundamentals and build up an orderly line of thought and attack on a problem; that makes him an accurate interpreter of the collective opinion of a group or committee; that finds a simple and practicable way in situations that are confusing to less alert persons. They know he has a tremendous capacity for work, that he has infectious enthusiasms, that he refuses to get the "jitters" when everything seems to be going wrong and there isn't time enough to do the job. They know the breadth of his interests. They know him as an initiator of new projects. And the more fortunate know the loyalty of his friendship, the consideration and thoughtfulness for others that kindle vital warmth in those friendships, and the unselfishness that modesty and a protective cloak of apparent indifference sometimes seek to hide. As his new duties will require him to travel extensively, the number of those who discover these things for themselves will increase to the wider vindication of these few tributes. Gentlemen—the new secretary!

Recovery in the Profession

THE new secretary of the A.S.M.E. merits and needs loyal and enthusiastic support. His problem is that of the Society in a recovery period. He has demonstrated his ability in administration. He has demonstrated his qualities of leadership and progressive thinking. He has been closely associated with the developments in the Society looking toward better society organization, clarified objectives, and a revitalized program. He has also been closely associated with the developments in the profession that are directed toward improved economic status, a better organized training for junior engineers, and a unified and rational basis for professional recognition that will enhance the dignity and effectiveness of engineering societies and engineers.

The tasks of the immediate future are those of recovery and greater service. The ground-work has been laid. What is needed now is intelligent and aggressive action to put into effect the programs that are being laid out. The American Society of Mechanical Engineers has set its house in order. It has dealt with its financial problems realistically and under heavy handicaps. From recent experience, during which a heavy portion of the burden was carried on the shoulders of the new secretary, much has been learned, and the Society is fortunate, for no one knows better than the man it has chosen to administer its affairs what

these lessons are. The status of membership has been treated realistically also, and while numbers have shrunk materially, there is every reason to believe that the nucleus that remains is sound and loyal. As time goes on, as personal fortunes mend, and as new engineers are drawn into the profession, the curve of membership will mount upward again; and a revaluation of the benefits, indirect as well as direct, that accrue to members, to the profession, and to industries and communities which are the beneficiaries, will strengthen purposes and kindle enthusiasm.

This is not the place to catalog these benefits, but brief mention may be made of a few groups of activities from which they spring. There is, for example, the important and urgent problem of providing adequately for the junior member who, upon graduation, suffers the intellectual depression and lack of stimulation of his early apprenticeship. Furthermore, there is the task of raising the economic and professional status of the engineer in cooperation with all groups and societies of engineers. There is the supreme obligation to develop the technological phases of mechanical engineering that furnished the reason for establishing a society of mechanical engineers and that has been so creditably discharged in the past. And there is the growing necessity of public service to be rendered, not only as individuals but also as a group, that a period of national economic recovery will most desperately require.

To these, and to other important tasks, the Society is alive, and the new secretary sympathetic.

Lessons From Disasters

BY SPECIAL request, H. L. Seward, who by tradition, training, and experience knows about men and ships, prepared a brief comment on the lessons of the *Morro Castle* disaster. We are so busy telling of the wonders and achievements of engineering that we seldom take time to drive home the lessons that failures of men and machines are able to teach us. Fortunately, such spectacular disasters as that of the *Morro Castle* are infrequent, but minor ones are of daily occurrence, and the generally evil and unsocial consequences of the abuse of machinery have far-reaching effects. There was the ill-fated *Akron*, the St. Francis dam, and the Quebec Bridge, to mention but a few. These are but the occasional reminders of the hazards of an age of machinery that gain head-line prominence. Day by day men are killed and maimed on the street, in the factory, at the construction location. Transportation takes its victims swiftly and spectacularly, with paralyzing suddenness, and under circumstances of emergencies that demand the supreme test of both man and machine. But occupational disease works slowly. Industrial accidents of a minor nature excite little comment. Dust, smoke, and industrial wastes take their toll of health and property. Men's souls are warped by maladjustment to the machine environment in which they work because their supervisors make no effort to adjust them properly to it. We do not need to go down to the sea in order to learn the lessons of the *Morro Castle*.

It ought to be a matter of principle with engineers that their machines give no offense, and that they do not transfer to machines greater responsibilities than these unthinking creatures can bear. A safety device that fails to function because of neglect brings disrepute to machinery and to the men who design and rely upon it. Nor must we think that the man is less important than the machine and fail to give proper thought to him and to his conditions of work. We may be able to transfer a certain amount of skill and work to machines and to make of them tireless and accurate servants, but that does not remove the need for intelligent and unremitting attention; it intensifies it.

Durable-Goods Industries

IN HIS presidential address, which will be published in accordance with a time-honored custom in the Transactions of The American Society of Mechanical Engineers, Colonel Doty dealt with the subject, "The Engineer and Recovery." He pointed out that mechanical engineers were vitally interested in any rational program for national recovery, that the work of the Society's members was primarily with the durable-goods industries, and that any national recovery program that would restore the prosperity of these industries was assured of the interest of the mechanical engineer. "To the engineer," he said, "work means overcoming resistance, and if there be resistance to any program of national recovery, therein is the challenge to the engineer to carry the program to success."

Colonel Doty's words carry many implications, but his very definite emphasis of the extent of the interest of the mechanical engineer in the durable-goods industries justifies the emphasis that is placed upon certain factors involved in them in this issue of MECHANICAL ENGINEERING. In the report of the study made at the request of the A.S.M.E. Committee on the Capital-Goods Industries that appears elsewhere in this issue there is evidence of the very practical way in which such an organization as the A.S.M.E. can serve in calling attention to features of NRA codes that restrict the recovery of these industries and that are, in the opinion of the committee, economically unsound.

Much controversy has waged and will continue to wage over the soundness of the provisions in NRA codes that restrict the use of machinery and production. A year ago MECHANICAL ENGINEERING directed attention to these restrictive provisions which, at that time, had been placed in 27 codes. The report which is published this month shows that this number has grown to 108. Surely we are getting ourselves so hamstrung with such provisions that the principles of orderly control of additions to temporarily overcapacitated industries may be lost in abuses that are essentially monopolistic in character and in jeopardizing the existence of the industries upon whose progressiveness and readiness

to serve the consumer-goods industries make for technological advance and abundant goods at low cost.

Without doubt, when the subject of the NIRA is discussed by the new Congress, this phase of it will receive the attention it deserves. Congressional opposition to restrictions which one group of industries places on others must not be allowed to go by default, however. Readers of MECHANICAL ENGINEERING, like other citizens, have access to their representatives at Washington and should present their side of the argument. The articles by Messrs. Houston and Hoadley, both members of the NRA Durable Goods Industries Committee, printed in this issue, will provide background material against which to array the facts gathered from the codes themselves by the Capital Goods Industries Committee.

A Good Job Done by Juniors

CONGRATULATIONS and expressions of appreciation should be extended to Messrs. Hopkins and Nelson for their study of the provisions contained in NRA codes restricting machinery and production. It was a tedious and painstaking task. It demonstrates, however, the practical manner in which junior members can be brought in to the active work of Society committees. It has frequently been pointed out in these pages that such connections as these two juniors formed with the Committee on the Capital-Goods Industries is mutually beneficial. This year the A.S.M.E. is attempting to assimilate 1400 graduates. If it could provide even the promise within five years of such experiences as Messrs. Hopkins and Nelson have had, no one would ever question the enormous impetus to Society activity and usefulness that would result or the interest of its members in the Society's program and objectives.

Frank J. Sprague

THE recent death of Frank J. Sprague gives rise to a host of thoughts on the work of that able and useful engineer. His important contributions were to the art of electrical engineering, and his active life covered that golden age of electrical development in which the uses of electricity in the power, lighting, and transportation fields were developed. Its history teaches so many lessons that only a few can be mentioned.

For example, these years saw the rapid development ot the electric street railway for which Frank Sprague is customarily honored. In a way the life cycle of this remarkable transportation scheme had been run before his death. In many of our cities the tracks had been taken up. Obsolescence and the keen competition of the automobile and the bus (who would have confidently foreseen either half a century ago?) had scrapped the equipment as outmoded and unsuited for modern city life. And yet, it is too early to say that the cycle is completed. Promise that a new phase may be beginning will be found in the "million dollar trolley car."

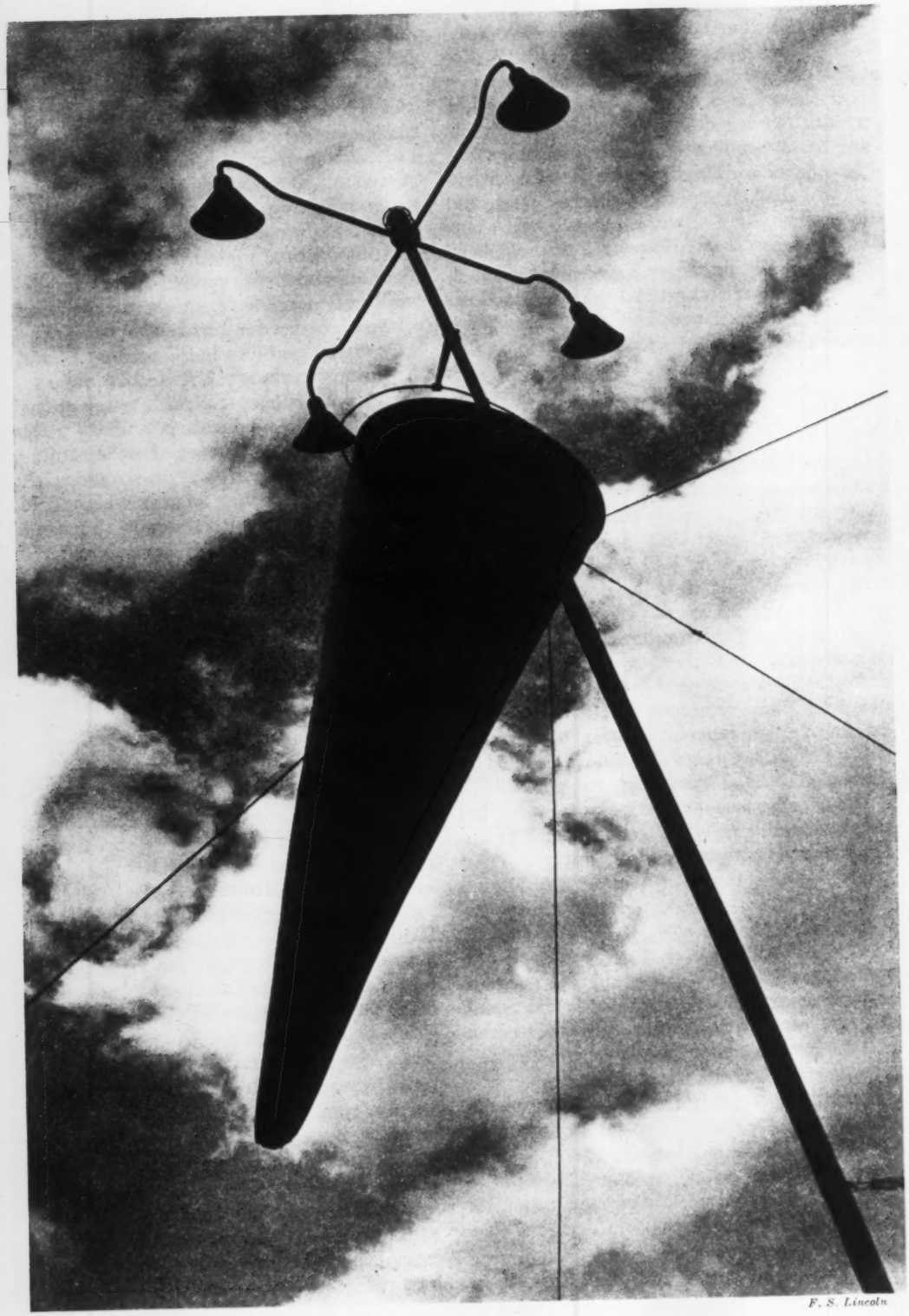
The lesson is the tremendous and unpredictable influence of technological change and the economic and social changes that follow in its wake. There is no justification for a smug sense of security in the minds of those whose interests today are wrapped up in some apparently stable element of our technological life. Somewhere, in a research laboratory, or an obscure shop, or in the minds of students of social legislation the seeds of competition are germinating. Alertness to scent the coming change is the basis of survival.

From another angle the influences of Frank Sprague's work on the development of modern living conditions are highly suggestive. Consider, for example, the effect of the high-speed electric elevator on the development of large cities, on office buildings and hotels, and on apartment houses. And if the electric street railway of thirty years ago has been eclipsed, what about the influences of the subway and the interurban electric train with its multiple-unit control? Furthermore, what has been the influence of the street-railway on the development of the central power station which made possible the widespread use of electricity in thousands of important and trivial ways? Just how different the world would have been if Frank Sprague had not lived it is useless to speculate, but we do find many of the contributions he made serving as important links in the amazing developments that took place in his lifetime.

Palmer C. Ricketts

THE sudden death, on December 10, of Palmer C. Ricketts, president of Rensselaer Polytechnic Institute and Honorary Member of the A.S.M.E., brings to a close, at the age of 78, the career of one of the most remarkable geniuses that engineering education has known. For thirty-three years president, for forty-two years director, and for fifty-nine years a member of the faculty of the pioneer engineering school of the United States, Dr. Ricketts had been privileged to give a longer period of service in his chosen field than is the average lot. That these years of service were years of wisdom and sound administration is proved by the fact that his astuteness and foresight provided for the financial as well as the intellectual integrity of his institution. So masterfully did he manage its financial affairs that in years when others were reducing staff and salary, he was able to take advantage of favorably low building costs and add to the physical plant at Troy.

The sorrow occasioned by his death is made more keen by reason of the fact that, during the coming spring, it had been his intention to commemorate the one hundredth anniversary of the granting of the first engineering degree given in an English-speaking nation. The historic event must now take place without his personal guidance. His place will be hard to fill, but his successor will find a sound and flourishing institution in tune with the progressive influences in modern education and a tradition in stewardship that cannot easily be maintained.



"To Know Where Sits the Wind"

PROPHETS *and* PANACEAS

By DEXTER S. KIMBALL

DEAN, COLLEGE OF ENGINEERING, CORNELL UNIVERSITY

If we will but listen we may hear many voices from the distant past repeating over and over again the eternal verities of life, and sages in all times have tried to epitomize these truths for our guidance. Plato tells us as an ancient Greek myth how the great God Zeus, when he placed life upon the earth, gave to each bird and beast strength or swiftness according to its needs in order to survive, and to man he gave *reason* and *fire.* Thus armed, man was able to hold his own against the beasts of the field. But when men began to live in cities they were so vicious toward each other that Zeus feared the race might become extinct. He therefore sent his messenger Hermes to distribute *justice and the sense of shame* in every human heart, for he said without these men would eventually exterminate themselves. This would appear still to hold true, and perhaps what we need most is not more legislation but higher ideals of justice and fair play. Be assured in any case that whatever may be good in the Square Deal, or the New Freedom, or the New Deal will also be found in the old deals, for the basis of social justice is eternal and does not change.

MAN in his long journey from savagery to civilization has never lacked for prophets and seers who could see, or pretended to see, what the future held for him. Every age has had its Jeremiahs, Ezekiels, and Isaiahs, and these have always been particularly vocal in times of depressions such as this, from the very beginning of the modern industrial era. Mr. Bancroft Gherardi in a booklet called "Engineers and Progress," published in January, 1933, has collected some of these prophesies. I quote very briefly from these more extended jeremiads.

Macaulay, the British essayist, writing in 1830, says: "The present moment is one of great distress..... We cannot absolutely prove that those are in error who tell us that Society has reached the turning point—that we have seen our best days. But so said all who came before us with just as much apparent reason."

Again in New Haven, Conn., in 1837, another writer remarks: "Already want like an armed man stands at the threshold of many a dwelling where a few days ago daily industry brought the supply of daily comforts. Amid these present calamities and these portentous omens of the future it is not strange that many minds are seeking and all voices debating the cause and the remedy." Once more in 1857 in *Harper's Magazine* we read: "It is a solemn moment and no man can feel an indifference in the issue of events. Of our own troubles no man can see the end." And again in 1886, or 48 years ago, Carroll D. Wright, Commissioner of Labor, writes in his first report: "This full supply of economic tools to meet the wants of nearly all branches of commerce and industry is the most important factor in the present industrial depression. It is true that the discovery of new processes of manufacture will undoubtedly continue and this will act as an ameliorating influence, but it will not leave room for a marked extension such as has been witnessed in the last fifty years, or afford a remunerative employment of the vast amount of capital which has been created during that period. The market price of products will continue low no matter what the cost of production may be. The day of large profits is probably past. There may be room for further intensive, but not extensive, development of industry in the present area of civilization." And so one could go on without end.

The great trouble with these prophets of despair is that they never have all the factors in the situation. The greatest and best illustration of this is found in the prophecy of Dr. Robert Malthus (1766–1834), a professor of Cambridge University. Malthus proved to his own satisfaction that the human race *if unrestricted* increased in the geometric ratio 1, 2, 4, 8, 16, 32, 64, 128, 256, doubling in numbers every 25 years. He stated that food supplies could be increased only in the arithmetic progression of 1, 2, 3, 4, 5, 6, 7, 8, 9. Thus in two centuries the ratio of population to food would be as 256 to 9 and in three centuries as 4096 to 13 and ultimately starvation must result. The "Malthusian theory," so called, was a most disturbing factor for many years and is still called to our attention, with the result that Malthus has come down to us as a prophet of despair rather than as the author of one of the best studies of population ever written. The difficulty with his theory lies in the dogmatic mathematical form in which it is stated. It is always unwise to extend a curve far beyond our present knowledge. Malthus could not see modern scientific agriculture, scientific canning and preserving, or modern transportation facilities which have made vast areas available for food supplies. It is doubtful if he fully appreciated the great industrial changes, taking place before his eyes, which were destined to enlarge man's idea of economic freedom.

It is against such a background that I have tried to

Seventh Henry Robinson Towne Lecture on Engineering and Economics. Delivered at the Annual Meeting, New York, N. Y., December 3 to 7, 1934, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

view the present situation. Let me remark in the beginning that I hope nothing I shall say will be construed as destructive criticism of the New Deal, so called, for there are some features of it that I heartily approve. It will be remembered that we have had similar slogans in recent years. Theodore Roosevelt announced a "Square Deal," Woodrow Wilson inscribed the "New Freedom" on his banner, and no doubt some of the features of both were economically as debatable as any features of the New Deal. History repeats itself; but the race is very slow in learning the lessons that it teaches, and it is of some of these lessons that I shall speak.

HUMAN FREEDOM IS POLITICAL, RELIGIOUS, AND ECONOMIC

Human freedom is of three degrees, political, religious, and economic, and the effort to attain some measure of such freedoms has been with man from the beginning and will follow him to the end. No large civilized nation has as yet been able to attain full freedom in all three degrees. The bloody story of man's effort to attain political and religious freedom with its awful toll of human lives needs no rehearsal here except to note how difficult it is to win such freedoms and how easy it is to lose them, as illustrated by the events in Russia and certain other European countries in the last few years. Political and religious freedom is enjoyed in only a very few lands today, and ours is one of them. Let us see to it that we do not lose it.

By economic freedom I mean freedom for all from poverty and all of its accursed results; freedom through the conquest of our material surroundings so that all men may live as men and not as beasts, and freedom to enjoy at least some of the finer things of life free from the haunting fear of unemployment, want, hunger, and the despair that has always been the lot of a large part of mankind.

So far as the great mass of humanity is concerned economic freedom has always been an idle dream and it was not until the advent of modern methods about 1800 that any hope whatever of universal well-being was offered to mankind. Any account of the growth of modern industrial and scientific methods has no place here, but it must suffice to state that by 1900, it is commonly agreed that for the first time in the history of man he could produce food, clothes, shelter, in fact everything required by human wants in an abundance never before seen on this earth, and economic freedom was a *possibility* so far as the methods of production were concerned. The average well-being in this country in the early part of this century was probably the highest ever attained by any great civilized country and what we might have done with this new power in times of peace we shall never know. The great war with its disjointing effects, the tremendous expansion of our industrial equipment which resulted, and the false prosperity that followed, all came at a most inopportune time, and as we crawl out of the debacle of 1929 the world is filled with confused thought and innumerable panaceas for our relief and for the prevention of future depressions.

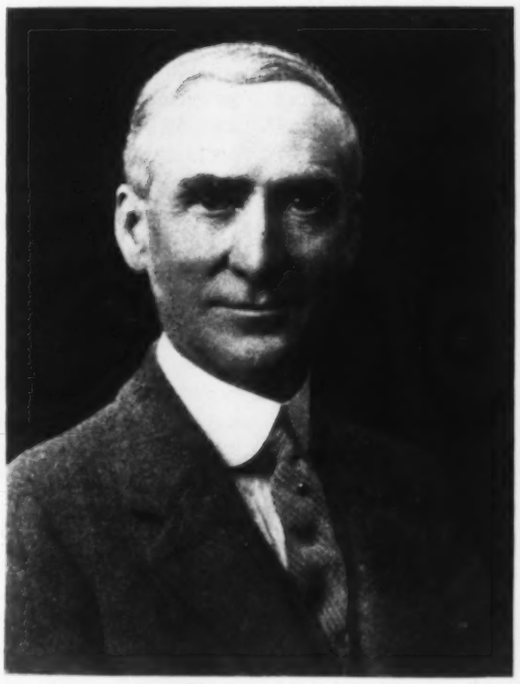
We are told that the world is basically changed and that never again can we hope to see anything like the good old times. We are told that we shall never again see an era like that of 1900–1914 unless we make radical changes in our political and social economy. Articles, pamphlets, and books in large numbers have been issued in recent months by engineers, professors, economists, lawyers, labor leaders, and others, offering explanations as to the causes of our troubles and panaceas for their cure and prevention. The Committee on the Balancing of Economic Forces appointed by the American Engineering Council recently reviewed and digested a large number of these efforts. These plans, coming as they do from intelligent men, present a baffling front. The single finding that the committee was willing to present, drawn from this presentation of causes and remedies, is that no one all-inclusive cause can be designated as the forerunner of business recession. Nor can any one all-inclusive remedy be found as a preventive or cure. Our business and industrial structure is certainly complex.

Now, of course, the world is changing and has been changing rapidly ever since the Industrial Revolution. The new industrial and scientific methods have tended constantly to separate the worker farther and farther from the ownership of his tools, they have separated agriculture from the mechanic arts to the degree that what benefits one group may not help the other. These new methods have broken up old trades and have created many new callings and they have created more employment than they have destroyed. Without doubt they have made the world a much more complex place and the industrial machine to which we are all bound hand and foot is much more delicately balanced than it was and hence much more easily thrown out of adjustment. But in spite of these drawbacks, it should be remembered that *these new methods are the only ones ever devised that are capable of giving us economic freedom.* To say that we cannot control this industrial machine in the interests of all is to admit our mental inadequacy. It will not be easy to do, but I believe it can be done.

It should be remembered, moreover, that all advances, whether industrial, political, or religious are, and always have been, accompanied by trouble and suffering. It appears to be inevitable that no great reform or betterment can be accomplished without suffering upon the part of many. Make no mistake in this matter. If we shall achieve economic freedom, a high standard of life, security and delight in work and leisure, as we have to some degree achieved political and religious freedom, it will be through much trouble and against no little opposition.

The several methods that are now being tried in Europe to cure modern industrial and social ills are worthy of more than a passing thought. We are not likely to adopt communistic methods in this country though we may enlarge our ideas of government ownership as regards some common necessities. Nor are we likely to permit the development of any form of dictatorship. It should be remembered, however, that, as pointed out over two thousand years ago by Greek phi-

losophers, the cycle of government is from a democracy to an oligarchy, from an oligarchy to a dictatorship, and through a violent upheaval from a dictatorship back to a democracy, and so on. A dictatorship might indeed solve some of our industrial problems, but a dictatorship whether by a minority group or an individual is always subversive of political freedom and usually subversive also of religious freedom. We shall do well to guard carefully the right to go to the polls periodically and change our rulers as we deem wise. Economic freedom at the expense of political and religious freedom would avail us very little. Who would have supposed that Germany would complete this cycle from dictator to dictator in the brief period of fourteen years?



DEXTER S. KIMBALL

1934 HENRY ROBINSON TOWNE LECTURER

SOME PROPOSED REFORMS IN SOCIAL ECONOMY

Consider now, in the light of the foregoing, some of the proposed reforms in our social economy. We are told that we are seeing the passing of laissez-faire or "rugged individualism," the inference being that the country is filled with industrial leaders who until now could do as they pleased. Such remarks display dense ignorance of the history of labor legislation during the past 100 years. As a matter of fact, laissez-faire has never been anything more than an economic theory, in civilized lands at least, and while no doubt there are many compensating characteristics in modern industrial economics, no modern nation has been willing to trust them to guard, for instance, the welfare of the working classes. The greatest curb ever put upon rugged individualism was the anti-trust legislation of the latter part of the last century, and history abounds with illustrations of legislation by the majority to control the minority. A mere glance at the industrial legislation of our older industrial states will verify this statement. Experiments such as we are now trying are very ancient. The Code of Hammurabi promulgated about 4400 years ago fixes the rates of pay for doctors, veterinarians, and all kinds of artizans and in many other ways regulates industry exactly as we are trying to do today. History does not tell us what success he had with his code. The Statute of Laborers enacted in England in 1349 and which, many times amended, was operative until the Industrial Revolution, originally fixed the minimum working day at 12 hours and otherwise legislated in favor of the employer rather than worker. Modern industrial legislation beginning with the English Factory Act of 1812 has tended to regulate industry in favor of the worker and the public and the NIRA simply extends the principle. In so far as it tends to eliminate abuses such as racketeering, unfair competition, and child labor, all thinking men will applaud the act as a progressive step.

What we are witnessing is nothing more than an extension of a very old principle, namely, that any community has always assumed the right to govern industry in its midst in so far as such industry affects the common welfare. In this particular instance we may find out how far the community may go with its regulatory power without destroying individual initiative.

And when the prophets disagree the case is even more serious. The history of depreciated currency is well known. King Henry VIII indulged in such an experiment with the usual results, and it has been tried at many other times and places. Yet today we have professional economists who presumably have made a study of such things divided in their opinions on monetary matters of all sorts. Some believe in a gold standard, some do not; some believe in "moderate" inflation, others will have none of it. To an engineer this is most disconcerting. In vain one inquires in engineering fashion, "What are the facts?" There are plenty of opinions but few convincing facts. Again, I know of no economic theory that justifies the destruction of food and cattle while thousands want for the necessities of life. On the one hand the President is committed to an increase in prices, while at the same time we have heard frantic appeals from other government officials to keep prices down. Such wide disagreements in economic policy are, as I have said, very disconcerting to the engineer whose methods are so much more direct and factual in their approach. They would appear ludicrous, indeed, if they were not so tragic in their implication. One is reminded of Omar who listened to

> "Doctor and saint and heard great argument
> About it and about; but evermore
> Came out by the same door wherein I went."

And always in times of depression the voices of the prophets are heard calling down the wrath of heaven on those who have led us into the wilderness of want and despair. In the last decade of the last century there was such an outcry known as "muckraking." It was directed, as is always the case, against the industrial,

business, and financial leaders. Unfortunately, there are always a few such leaders who, through lack of rectitude, give strength to such attacks, though the great majority of our industrial, commercial, and banking leaders are honest, hardworking, and human. I would suggest that right now is a good time to reread Elbert Hubbard's "Message to Garcia." The great difficulty is that these outcries are undiscriminating in character and defame the good with the bad. Theodore Roosevelt speaking in 1906 defined muckraking as "the effort to make financial or political profit out of the destruction of character." We are hearing not a little of this sort of thing today, and this "anti-industrial complex," as Dr. Virgil Jordan has called it, is a disturbing matter. It fosters a belief on the part of many that modern industrial methods are a menace to our national life and should be sharply curbed; a belief that those who manage industry have obtained the lion's share of the benefits as compared to the actual worker and that we should "take from those that have and give to those who have not," as one prominent senator has expressed it. No one doubts that a more equitable distribution of the national income would be desirable, both on economic and humane grounds, and, incidentally, if taxes, direct and indirect, are an index, such a distribution is fairly well under way.

But there are only two horns to this dilemma. Either we must go to widely extended outright government ownership with its mediocre initiative and leadership or continue to depend upon individual efforts. The proportion of men in any group, great or small, competent to initiate and manage large enterprises of any kind is very small. In a similar way the scientists and engineers constitute a very small percentage of the population. This group can be regulated and regimented just so far and still produce its best results. Genius does not work well in harness, and the old law of diminishing returns applies here as elsewhere, and if regimentation is pressed too far the result cannot fail to be as thus described by Dr. Virgil Jordan:

> In the first place, and most fundamentally, it must lead to a gradual lowering of the standard of living, or at least to a greatly retarded rise in the standard of living. The economic welfare of any nation is dependent basically upon its output of work, the volume of goods and services or real wealth that it produces. We may shift debt burdens from one group to another and artificially redistribute wealth and income; but no nation can raise its standard of living merely by raising prices and wages through monetary manipulation or group agreement, or through curtailment of output and restriction of productive effort. The most important factor in the productive accomplishment of any people is the enterprise and effort of individuals, as investors, speculators, inventors, organizers, and managers. The crippling of individual initiative and enterprise through the expanding of bureaucratic agencies must inevitably lower the level of effective production, restrict opportunities for employment, and reduce the standard of living.

These are thought-provoking words. The greatest asset that any nation can possess is the skill, knowledge, and initiative of its industrial and business leaders, and probably we can better afford to put a few of our too ambitious leaders in the penitentiary, occasionally, rather than exterminate or suppress the entire group.

In any case, we are due soon to find out how far we can legislate ourselves into prosperity, or rather we shall find out perhaps how far we may assist natural economic laws through legislation. And the experience may be trying for many of us.

The greatest difficulty with the economic prophet lies, of course, in his panaceas especially when they assume, as they often do, the form of legal enactments. This is particularly true when these enactments aim at changes or corrections of our ethical code. It is difficult for him to see that law itself is an expression of our ethics and no law can possibly be effective that does not have the support of the vast majority of the people. If I have any criticism of the New Deal it is the apparent effort under the NRA to compel men to be just and fair. The intent is good, but the difficulties are great. No man's ethics, politics, or religion has ever been changed because of the enactment of any law. Our ethical beliefs are a complex composite built up from inheritance, environment, and experience and are not changed by change in the law. Witness the many thousands that have died for their religious or political faith. If all men were just and fair we should have little need of industrial legislation of any kind. But unfortunately this country contains a large number of people in whom justice does not reside and who do not hesitate to take advantage of their neighbor even though they may transgress the law in so doing. It will require an immense police force to make any such enactment as the NRA effective. Our recent experience with prohibition has apparently taught us very little concerning the regulation of business ethics. It is impossible to legislate goodness into the hearts of unregenerate persons. On the whole we have made much progress during the last century toward a more enlightened and fairer industrial system, and our greatest hope lies, not in legislation, but in higher ethical standards on the part of those who control industry, commerce, and banking.

And again there is nothing new in this statement. If we will but listen we may hear many voices from the distant past repeating over and over again the eternal verities of life, and sages in all times have tried to epitomize these truths for our guidance. Plato tells as an ancient Greek myth how the great god Zeus, when he placed life upon the earth, gave to each bird and beast strength or swiftness according to its needs in order to survive, and to man he gave *reason* and *fire*. Thus armed, man was able to hold his own against the beasts of the field. But when men began to live in cities they were so vicious toward each other that Zeus feared the race might become extinct. He therefore sent his messenger Hermes to distribute *justice and the sense of shame* in every human heart, for he said, without these men would eventually exterminate themselves. This would appear still to hold true, and perhaps what we most need is not more legislation but higher ideals of justice and fair play. Be assured in any case that whatever may be good in the Square Deal, or the New Freedom, or the New Deal will also be found in old deals, for the basis of social justice is eternal and does not change.

Code Restrictions on MACHINERY *and* PRODUCTION

In 108 NRA Codes There Are 163 Provisions Limiting the Extension and Use of Plant Capacity and Restricting Industrial Production

By W. E. HOPKINS and J. F. NELSON

In the report of the Committee on Capital-Goods Industries of The American Society of Mechanical Engineers printed in the October issue of MECHANICAL ENGINEERING, an announcement was made that a study of the restrictions on manufacturing equipment in the Codes of Fair Practise was under way. That investigation is now completed, and the resulting report accompanies this statement. The Committee acknowledges its indebtedness, and expresses its appreciation, to Messrs. Hopkins and Nelson for the diligent analytic work which has brought this research to a conclusion. The report is a comprehensive tabular presentation of the code provisions which restrict the use of machinery and limit industrial output. How much these requirements have hampered American industry during the past 21 months cannot be determined. Instances and cases of this nature have been brought to the attention of the members of the Committee. The situation revealed by the report justifies this observation: If restrictions like those presented had prevailed in American industry during the first quarter of this century, much of the industrial progress and the rise in the standard of living that came therefrom would never have been enjoyed. It is the opinion of the Committee that the continuance of restrictions of this type is not in the public interest nor conducive to healthy industrial development.

CAPITAL-GOODS INDUSTRIES COMMITTEE[2]

A CLOSE connection between economic belief and political action is shown by the provisions in the Codes of Fair Practise having to do with the limitations and restrictions on producing machinery and production. The belief has been stated that the depression was due largely to too much manufacturing equipment (capital goods) and too great a production of articles, goods, and services. This belief has been shared by business men and the officials of the National Recovery Administration. As one result, provisions to restrict the installation and use of manufacturing and service equipment and plant capacity and to limit production were written into 108 codes.

When considering this circumstance it is instructive to recall an eminent engineer's prediction of the economic catastrophe which has overtaken us. Early in 1919, Henry Laurence Gantt, an honored member of the A.S.M.E., foretold the coming of the depression and said that it would be attributed, falsely, to "overproduction." He said:

> Overproduction has been the bugbear of American business. Our periodic panics have all been laid to this. From time to time we have produced so many goods that it was thought there was no market for them, and the industries have had to shut down. This brought unemployment and poverty, with consequent inability to buy the things we had produced. The workers then had to go ragged because they had produced so many clothes. They had to go barefooted because they had produced so many shoes. They had built so many houses that they had to live outdoors. Can any one find an excuse for continuing such a system of industry?
>
> How to curtail production and avoid glutting the market has often been a problem of our business interest. Curtailing production means shutting down the plant, wholly or in part. The "captain of industry" by this measurement thus becomes too often a captain of idleness. The way to get rich, he discovered, was to quit producing wealth.
>
> We have never had overproduction yet. We have never produced more things than we wanted. All that we have done is to produce more than we could buy. With distribution simplified, that bugbear would be removed.[1]

In 108 NRA codes there are a total of 163 provisions in these documents having as their objective some control of producing equipment, productivity and production. These requirements are conveniently classified in Table 1.

Certain other provisions in the 503 codes examined in this study might be interpreted as tending toward these same forms of control. Among them are restrictions on home work, price fixing, and prohibitions against certain trade practises. These sections of the codes were omitted for the reason that they do not directly concern either the utilization of industrial capacity or the output of product.

No attempt has been made to study amendments, interpretations, and explanations of the codes, although some of these modifications are known to deal with restrictions of the kind with which this report is concerned. The difficulty of securing this information is a reason for this omission. Another is that these changes, in general, concern working hours, with a tendency to shorten still further the periods originally specified.

[1] "Life of Henry Laurence Gantt," by L. P. Alford, pp. 278–279.

[2] This committee, appointed by the Council of The American Society of Mechanical Engineers in September, 1933, consists of the following: L. P. Alford, *Chairman*, Ralph E. Flanders, W. W. Macon, and L. W. W. Morrow. This report was submitted to the Council on Dec. 3, 1934.

Messrs. Hopkins and Nelson are junior members, A.S.M.E., to whom the Committee assigned the task of analyzing the codes.

The results of this study of the Codes of Fair Practise have been arranged in two tables. Table 2 is a list of the NRA codes in which restrictions on machinery and production were found. It is arranged on the basis of code numbers. The column at the right gives the key to the particular restrictions found in each code. The key letters and numbers are the same as those used in Table 1. A condensed statement of the provision in any code will be found in Table 3.

Table 3 is arranged in accordance with the classifications listed in Table 1. Each item in the table contains the NRA code number, the title of the code, the article and section in which the restrictive provision is to be found, and a condensed statement of the language of the provision.

TABLE 1 CLASSIFICATION OF RESTRICTIVE PROVISIONS IN 108 NRA CODES

		Number of codes where provision is found
A	*Capacity and Equipment Control*	
(1)	Direct prohibition upon extension of capacity	1
(2)	Requiring authorization for extension of equipment	21
(3)	Restrictions to be recommended by Code Authority	
	Shall be recommended	15
	May be recommended	8
(4)	Restrictions by agreement	3
(5)	Restrictions on rearrangement of equipment	5
(6)	Disposal of obsolete equipment	2
(7)	Registration only required of productive machinery	5
(8)	Restrictions on offering machinery as inducement to sale	1
	Total	61
B	*Productivity and Production Control*	
(1)	Allocation of production Inventory and quotas	5
(2)	Regulations permitted	8
(3)	Regulations to be recommended	8
(4)	Restrictions on operating time	60
(5)	Restrictions on number of machines per operator	5
(6)	Restrictions on productivity	16
	Total	102
	Grand Total	163

TABLE 2 NRA CODES CONTAINING MACHINERY AND PRODUCTION RESTRICTIONS

Code No.	Industry	Key to Table 3
1	Cotton Textile	A3, B4, B6
3	Wool Textile	B4, B6
5	Coat and Suit	B4
6	Lace Manufacturing	A3, B4
7	Corset and Brassiere	B4
9	Lumber and Timber Products	B2
10	Petroleum	A4, B1, B2
11	Iron and Steel Industry	A1, B2
15	Men's Clothing	B4, B6
16	Hosiery	B4, B5, B6, A3
18	Cast Iron Soil Pipe	B4
19	Wall Paper Manufacturing	B4
23	Underwear and Allied Products Manufacturing	B4, B6, A7
27	Textile Bag	B4, A3
28	Transit	A2
29	Artificial Flower and Feather	B3
34	Laundry and Dry Cleaning Machinery Manufacturing	A5
36	Glass Container	A2, B4
43	Ice	A2
48	Silk Textile	B4, A7
51	Umbrella	B4, A7
53	Handkerchief	B4
54	Throwing	B4, A3, B3, B5
64	Dress Manufacturing	B4
66	Motor Bus Industry	A2
67	Fertilizer	A3, B3
78	Nottingham Lace Curtain	B4, B6
79	Novelty Curtain Draperies, Bedspreads and Novelty Pillow	B4, B6
82	Steel Casting	A3
90	Funeral Supply	B4
92	Floor and Wall Clay Tile Manufacturing	A2
99	Asphalt Shingle and Roofing Manufacturing	A3, B3
108	Motor Fire Apparatus Manufacturing	A6
109	Crushed Stone, Sand and Gravel, and Slag Industries	A2
111	Air Transport	A2, A3
112	All Metal Insect Screen	B6
113	Limestone	A3
118	Cotton Garment	B4, A3
119	Newsprint	B4
120	Paper and Pulp	A3, A5
123	Structural Clay Products	A2
125	Upholstery and Drapery Textile	B4, B5, B6
128	Cement	B2, A2, A6, A5, (B1)
135	Cigar Container	B4
140	Waterproofing, Dampproofing, Caulking Compounds, and Concrete Floor Treatments Manufacturing	B6
143	Wool Felt Manufacturing	B6
146	Excelsior and Excelsior Products	A2, A5
147	Motor Vehicle Storage and Parking Trade	A4
148	Pyrotechnic Manufacturing	A2
149	Machined Waste Manufacturing	B4, A3, A2
151	Millinery	B3
156	Rubber Manufacturing	A3, B4
157	Hair Cloth Manufacturing	B4, B6
164	Knitted Outerwear	B4, B5
166	Wax Paper	B4, A3
168	Refractories	A2
172	Rayon and Silk Dyeing and Printing	B4, A2
174	Rubber Tire Manufacturing	A3
175	Medium and Low Priced Jewelry Manufacturing (Machine Chain Division)	B4
183	Household Ice Refrigerator	B6
188	Velvet	A3, B4, A7
190	Paper Stationery and Tablet Manufacturing	B4, A3
192	Cast Iron Pressure Pipe	B2
194	Blouse and Skirt Manufacturing	B4
202	Carpet and Rug Manufacturing	B1
211	Robe and Allied Products	B4
212	Drapery and Upholstery Trimming	B4, B6
214	Slit Fabric Manufacturing	B4
215	American Glassware	A2
217	Dental Laboratory	B4
220	Envelope	B4
226	Light Sewing Industry Except Garments (Mattress Cover Division)	B4 B4
227	Wet Mop Manufacturing	B4
235	Textile Processing	B4
237	Alloy Casting	A3
245	Corrugated and Solid Fiber Shipping Container	B2, A3
253	Animal Soft Hair	B4
256	Schiffli, The Hand Machine Embroidery and Embroidery Thread and Scallop Cutting	B4, B5
259	Hat Manufacturing	B4
262	Shoulder Pad Manufacturing	B4
264	Foundry Equipment	B3
269	Carbon Black Manufacturing	B1, A2
276	Pleating, Stitching and Bonnaz and Hand Embroidery	B4
281	Laundry Trade	B4
283	Ready-Made Furniture Slip Cover Manufacturing	B4
302	Candle Manufacturing and Beeswax Bleachers and Refiners	A2
303	Cordage and Twine	B4, A2
309	Solid Braided Cord	B4, A3
311	Ready-Mixed Concrete	A3, A4
312	Narrow Fabrics	B4, B6
324	Textile Print Roller Engraving	B4
328	Tapioca Dry Products	A8
336	Covered Button	B3
364	Clay Drain Tile Manufacturing	A2
368	Print Roller and Print Block Manufacturing	B4
388	Sandstone	A3
389	Clay and Shale Roofing Tile	A2, A5
393	Soft Fiber Manufacturing	B4
400	Celluloid Button Buckle and Novelty Manufacturing	B4
401	Copper	B1

TABLE 2 (*Continued*) NRA CODES CONTAINING MACHINERY AND PRODUCTION RESTRICTIONS

TABLE 2 (*Continued*) NRA CODES CONTAINING MACHINERY AND PRODUCTION RESTRICTIONS

Code No.		Key to Table 3
408	Undergarment and Negligee	B4, B2
436	Fur Manufacturing	B4
442	Lead	B3
457	Cap and Cloth Hat	B2, B4
479	Cold Storage Door Manufacturing	A7
494	Merchant and Custom Tailoring	B4
496	Collective Mfg. for Door-to-Door Distribution	B6
499	Refrigerated Warehousing	A2

TABLE 3 CODE RESTRICTIONS ON MANUFACTURING CAPACITY, PRODUCTIVITY, AND PRODUCTION

A—CAPACITY AND EQUIPMENT CONTROL

(Total Number of Codes Affected, 61)

A1 DIRECT PROHIBITION UPON EXTENSION OF CAPACITY

11—*Iron and Steel* (Art. V, Sec. 2, p. 13). No member shall initiate construction of any new blast furnace, or open hearth or Bessemer steel capacity.

A2 REQUIRING AUTHORIZATION FOR EXTENSION OF EQUIPMENT

28—*Transit Industry* (Art. II, Par. A-4 (a), p. 375). Establishment of new and extension of old bus routes or lines in Interstate Commerce.

36—*Glass Container* (Art. VII, p. 463). Installation of new or enlargement of present melting areas.

43—*Ice* (Art. XI, p. 8). Certificate of necessity and convenience from Administrator required for establishing of additional ice-making capacity, storage, or production.

66—*Motor Bus* (Art. VII, Pars. 1 (a) and (6), pp. 114–115). (1) Registration of operations; (2) certificate of convenience and necessity required for any new operation.

92—*Floor and Wall Clay Tile Mfg.* (Art. VI, Par. 7, p. 451). (1) Registration of kiln capacity; (2) installing additional kiln capacity.

109—*Crushed Stone, Sand, Gravel and Slag* (Art. VII, Sec. 5 (a), (b), (c), (d), (f), pp. 658–659). In established "permissive areas" permission to increase production capacity required from Code Authority.

111—*Air Transport* (Art. VII, p. 8). With respect to existing routes the establishment of any extension of an existing route and prior to the establishment of any new route or service, each member shall file with Code Authority: (1) Certificate of Authority to operate issued by U. S. Dept. of Commerce; (2) information required by Code Authority; (3) evidence of compliance with standards and conditions of operation established by Administrator.

123—*Structural Clay Products* (Art. VII, p. 205). Certificate for increasing existing producing capacity or starting of existing plants shut down for 3 years or more.

128—*Cement* (Art. VII, p. 334). Prior to (1) construction or operation of a new plant; or (2) increase in productive capacity of an existing one; or (3) movement of all or part of existing plant; the Cement Institute *may* petition President to prohibit.

146—*Excelsior and Excelsior Products* (Art. X, Pars. 1 and 2, pp. 575–576). (1) Registration of productive machinery; (2) certificate of public convenience and necessity for new productive capacity or rearrangement of existing producing machinery to create additional productive capacity.

148—*Pyrotechnic Manufacturing* (Art. VIII, Sec. 1 and 2, p. 604). Permission of Administrator required for additional plant capacity.

149—*Machined Waste Mfg.* (Art. VI, Sec. 2, Par. 1, p. 613). (1) Registration of productive machinery. (2) certificate from Administrator for installation of additional producing capacity.

168—*Refractories* (Art. IX, Par. 3, pp. 273–274). Consent of Administrator for additional capacity of fire, clay, and silica brick or spec a shop production.

172—*Rayon Silk Dyeing and Printing* (Art. XI, Pars. 1, 2, 3, 4, p. 322). (1) Registration of existing productive machinery and replacements; (2) certificate from Administrator for installation of new productive machinery except for replacement.

215—*American Glassware* (Art. IX, Sec. 1, 2, and 3, p. 270). (1) Registration of present melting capacity of continuous tank equipment and tonnage capacity of furnaces and day tanks; (2) no new or additional melting capacity except for replacement permitted without certificate granting permission from Administrator.

269—*Carbon Black Mfg.* (Art. IV, Sec. 2, p. 6). Any material increase in plant capacity shall be made only after approved by Code Authority subject to approval of Administrator.

302—*Candle Manufacturing* (Art. VIII, Sec. 1, pp. 253–254; Sec. 2, p. 254). (1) Permission of Administrator required to obtain or use productive machinery not owned, leased, or otherwise held prior to Code effective date; (2) transfer of existing productive machinery from one manufacturer to another person permitted if it does not create additional productive machinery within the industry; (3) no member shall engage in manufacture in any of the three recognized fields of production if he has not engaged in that field at some time during the period of two years immediately prior, except by permission of Administrator.

303—*Cordage and Twine* (Art. IX, p. 265). Certificate from Administrator required to obtain or use productive machinery not owned, leased, or held prior to effective date of Code.

364—*Clay Drain Tile Mfg.* (Art. VII, Sec. 3, pp. 494–495). (1) Present kiln capacity shall be registered; (2) approval of Administrator required to install additional kiln capacity.

389—*Clay and Shale Roofing Tile* (Art. X, pp. 231–232). (1) Registration of kiln capacity. (2) approval of Administrator required for installation of additional kiln capacity, excepting modernization or replacement, or to devote to the manufacture of clay, shale roofing, tile kilns not used for such purpose during 3 year period ending Feb. 1, 1934.

499—*Refrigerated Warehousing* (Art. VIII, Sec. 1, p. 35). Permission of Administrator required for obtaining additional storage capacity.

A3 RESTRICTIONS TO BE RECOMMENDED BY CODE AUTHORITY

(a) *Shall Be Recommended*

54—*Throwing* (Art. IV, Par. 2, p. 650). Purchasing or building of throwing machinery.

82—*Steel Casting* (Art. VII, Sec. 4, p. 7). Board of Directors shall submit to Administrator for approval of such plan or plans for Limitation of Steel Foundry melting capacity as are deemed necessary.

118—*Cotton Garment* (Art. IX, Sec. 1, Par. (e) 6, p. 99). Control of undue expansion of productive machinery capacity.

120—*Paper and Pulp* (Art. IX, Par. 5 (c), p. 127). (1) Creation of new facilities for manufacturing of any product; (2) acquisition of new equipment for such manufacturing; (3) shifting of equipment from manufacturing of one kind or type of product to another.

174—*Rubber Tire* (Art. XI, Sec. 4, p. 352). Survey of productive capacity concerning desirability of limiting creation of additional productive capacity.

237—*Alloy Casting* (Art. V, Sec. 9, p. 571). Careful study of question of limitation of alloy melting capacity and shall submit to Administrator plan or plans.

311—*Ready Mixed Concrete* (Art. VII, Sec. 4, Par. (a), p. 384). (1) Survey of existing productive capacity and current and potential demands for the products in each marketing area; (2) recommendations to avoid overcapacity in any marketing area.

(b) *May Be Recommended*

1—*Cotton Textile* (Art. VI, Par. 3, p. 17). (1) Registration of productive machinery; (2) certificate for installation of additional productive machinery except for replacement or to balance existing productive machinery.

6—*Lace Manufacturing* (Art. V, Par. 3, p. 3). Registration required of productive machinery and certificate for installation of additional capacity.

16—*Hosiery* (Art. IX, Par. (e) (3), p. 248; (2) Par. (e) (4), p. 248). (1) Registration of productive equipment and certificate for installation of additional capacity; (2) acquisition and disposal of used equipment or scrapping of obsolete equipment.

27—*Textile Bag* (Art. VI, Par. (c), p. 367). (1) Registration of productive machinery; (2) certificate for installing additional capacity.

67—*Fertilizer* (Art. V, p. 127). Fertilizer Recovery Committee may submit to the Administrator recommendations for amendments to this Code or for such other action as may be appropriate because of overproduction.

99—*Asphalt Shingle and Roofing Mfg.* (Art. VI, Sec. 2, Par. (e), p. 532). Code Authority shall make a study of conditions in the industry and *may* make recommendations with respect to limitation of new equipment.

111—*Air Transport* (Art. VII, Sec. 3, p. 8). Evidence of compliance with Standards and conditions of operation as approved by Administrator upon recommendation of Code Authority.

113—*Limestone* (Art. VI, Sec. 2, p. 28). (1) Registration of productive machinery; (2) certificate prior to installation of additional productive machinery that such installation will be consistent with policy of NIRA; (3) granting or withholding by Administrator of such certificates.

149—*Machined Waste Mfg.* (Art. VI, Sec. 2, Par. 2, p. 613). Plan to prevent demoralization in industry wherever operations are below 35 per cent registered capacity.

156—*Rubber Manufacturing* (Art. VIII, p. 97, Rubber Footwear Division; also Art. VI, p. 107, Mech. Rubber Goods Division). Survey of productive capacity concerning desirability of limiting expansion.

166—*Wax Paper* (Art. VIII, Par. 1 (6), p. 241). Creation of new

facilities for manufacturing any product or acquisition of new equipment for such manufacturing.

188—*Velvet* (Art. VI, Par. 4, p. 545). Certificate from Administrator for installation of additional productive machinery except replacement of velvet looms by looms of same width.

190—*Paper Stationery and Tablet Mfg.* (Art. VIII, Sec. 1, Par. 6, p. 568). Creation of new facilities for manufacturing any product or acquisition of new equipment for such manufacture.

245—*Corrugated and Solid Fiber Shipping Container* (Art. IX, Par. 1 (f), p. 12). For registration of productive equipment and regulation of installation of new productive equipment.

309—*Solid Braided Cord* (Art. IX, Par. 6 (a), p. 357). (1) Registration of productive machinery; (2) certificate from Code Authority prior to installation of additional productive machinery except for replacement or to bring existing productive machinery into balance.

388—*Sandstone* (Art. VI, Sec. 2, Pars. 1, 2, and 3). (1) Registration of productive machinery; (2) certificate from Administrator prior to installation of additional productive machinery.

A4 RESTRICTIONS BY AGREEMENT

10—*Petroleum* (Art. I, Sec. 5, p. 4). Agreements for purpose of eliminating wasteful duplication of manufacturing, transportation, and marketing facilities are permitted subject to approval of the President.

147—*Motor Vehicle Storage and Parking Trade* (Art. VIII, p. 588). Any group of members may agree not to participate in providing of additional storage or parking facilities—subject to approval of Administrator.

311—*Ready Mixed Concrete* (Art. VII, Sec. 4, Par. (b), p. 385). Any group of members may agree not to be a party to any action which will increase productive capacity within any marketing area—subject to approval of Code Authority and Administrator.

A5 RESTRICTIONS ON REARRANGEMENT OF EQUIPMENT

34—*Laundry and Dry Cleaning Machinery Manufacturing* (Art. XII, p. 444). Resale of Machinery below trade-in allowances not permitted.

120—*Paper and Pulp* (Art. IX, Par. 5 (c), p. 127). The Paper Industry Authority may recommend restrictions on shifting of equipment from the manufacture of one kind or type of product to another.

128—*Cement* (Art. VII, p. 334). Movement of all or part of existing plant from one place to another may be prohibited by President upon petition of Cement Institute.

146—*Excelsior and Excelsior Products* (Art. X, Par. 2, p. 576). Certificate of public convenience and necessity required from Administrator to transfer productive machinery if effect is to create additional productive capacity.

389—*Clay and Shale Roofing Tile* (Art. X, p. 232). Approval of Administrator is required to devote to the manufacture of clay and shale roofing tile, kilns not used for such purpose during 3 year period ending Feb. 1, 1934.

A6 DISPOSAL OF OBSOLETE EQUIPMENT

108—*Motor Fire Apparatus* (Art. VII, Sec. 2, Par. 5 (c), p. 636). The Code Authority shall make recommendations to the Administrator concerning the regulation of the disposal of obsolete goods.

128—*Cement* (Art. VII, Par. 2, p. 335). Board may submit to Administrator plans for closing down or amortization of the less economical plants.

A7 REGISTRATION *only* REQUIRED OF PRODUCTIVE MACHINERY

23—*Underwear and Allied Products Mfg.* (Art. IV, Par. 3, p. 319). Each unit of productive machinery.

48—*Silk Textile* (Art. VII, Par. 1 (6), p. 4). In case of mills that have looms, reports shall be made every four weeks, showing number of looms in place, the number of looms actually operated each week, the number of shifts and the total number of loom hours each week.

51—*Umbrella* (Art. VII, Par. 1 (b), p. 3). Reports every four weeks specifying the number of machines as set up; number of machines actually in operation each week, the total number of work hours for each machine each week and the number of machines owned and the number of machines hired.

188—*Velvet* (Art. VIII, Pars. 2 and 3, p. 546). Complete inventory of productive machinery actually installed or under contract and a monthly inventory of all additional productive machinery specifying if for replacement, expansion, or otherwise.

479—*Cold Storage Door Mfg.* (Art. IX, p. 45). Number of shops, establishments, or separate units thereof and their location as well as each additional shop, establishment, or separate unit opened after registration.

NOTE—Other Codes requiring registration of productive machinery along with restrictions on capacity or production will be found under those headings.

A8 RESTRICTION ON OFFERING MACHINERY AS INDUCEMENT TO SALE

328—*Tapioca Dry Products* (Art. VII, Par. 12, p. 603). Unfair competition to give, rent, or sell any new or additional machinery or equipment to any buyer except as a replacement by a seller of dry vegetable glue to the wood-working industry.

B—PRODUCTIVITY AND PRODUCTION CONTROL

(Total number of Codes affected, 102)

B1 ALLOCATION OF PRODUCTION

(Inventory and Quotas)

10—*Petroleum* (Art. III, Sec. 3, p. 7; Sec. 4, p. 8; Sec. 5, p. 8). Required production of crude oil to balance consumer demand for petroleum products to be subdivided and allocated into quotas of production.

Petroleum (Art. III, Sec. 2, p. 7). Withdrawal of crude oil from storage subject to approval of Committee. Additions of crude oil to storage beyond the necessary limit of fluctuations in working stocks subject to approval of Committee.

Petroleum (Art. IV, Sec. 4, p. 11). Storage of gasoline in amounts greater than required by demand as determined by Committee is prohibited.

128—*Cement* (Art. VI, pp. 333–334) (See B2). The Board is authorized to submit a plan or plans for the equitable allocation of available business among all members and for the control of cement inventory.

202—*Carpet and Rug Mfg.* (Art. VII, Par. 2, p. 92). Finished goods (carpets and rugs) inventory limited to $^1/_3$ of sales for immediately preceding 12 months.

Carpet and Rug Mfg. (Art. IX, Par. 1, p. 96). Finished yarns inventory limited to $^1/_6$ of sales for immediately preceding twelve months.

269—*Carbon Black Manufacturing* (Art. IV, Sec. 1, p. 6). Each member to so regulate its current production of all ordinary grades of carbon black as to prevent same from exceeding its current deliveries.

401—*Copper* (New Art. VII, Par. 6, pp. 381–387). Allocation of production authorized on basis of sales quotas.

B2 REGULATIONS PERMITTED

9—*Lumber and Timber Products* (Art. VIII (a), p. 10). Authority shall determine estimates of consumption and to establish production quotas.

10—*Petroleum* (Art. III, Sec. 2, p. 7). Additions of crude oil to storage beyond the necessary limits of fluctuations in working stocks, subject to approval of Committee.

Petroleum (Art. III, Sec. 7, p. 10). Shipment of petroleum or the products thereof produced in a new field or pool not developed in accordance with plan approved by President (Wild-catting) is prohibited.

11—*Iron and Steel* (Art. V, Sec. 1, p. 13). Board of Directors is empowered subject to approval of President to make, modify, or rescind any rules and regulations for purpose of controlling and regulating production.

128—*Cement* (Art. VI, pp. 333–334). The Board is authorized to submit a plan or plans for the equitable allocation of available business among all members and for the control of inventory.

192—*Cast Iron Pressure Pipe* (Art. VI, Sec. 3, p. 585). Board of Control shall collaborate with members from time to time, when necessary, shall advise them concerning their production—subject to approval of Administrator.

245—*Corrugated and Solid Fiber Shipping Container* (Art. VII, Par. 1, p. 11). Members may join in voluntary agreement for the sharing of their business.

408—*Undergarment and Negligee* (Art. III, Par. 7, p. 499). Subject to approval of Administrator, the Code Authority may designate the hour before which work shall not begin and the hour after which work shall cease and may determine in which locality the rule shall apply.

457—*Cap and Cloth Hat* (Art. III, Sec. 5, p. 197). Subject to approval of Administrator, the Code Authority may designate the hour before which work shall not begin and the hour after which work shall not continue—need not be uniform throughout the country.

B3 REGULATIONS TO BE RECOMMENDED

29—*Artificial Flower and Feather* (Art. III, Par. 2, p. 1). Subject to review of Administrator, the Code Authority may designate the hour before which work shall not begin and after which work shall not continue.

54—*Throwing* (Art. IV, Par. 3, p. 651). Number of spindles to be operated by an employee to be recommended by Code Authority Committee for approval of Administrator.

67—*Fertilizer* (Art. V, p. 127). Fertilizer Recovery Committee may submit to the Administrator recommendations for amendments to this Code or for such other action as may be appropriate because of overproduction.

99—*Asphalt Shingle and Roofing Manufacturing* (Art. VI, Sec. 2, Par. (e), p. 532). Code Authority shall make a study of conditions in the industry and may make recommendations to Administrator with respect to limitation of production.

151—*Millinery* (Art. III, Par. 9, p. 6). Subject to review of Administrator, the Code Authority may designate the hour before which work shall not begin and after which work shall not continue.

264—*Foundry Equipment* (Art. VI, Par. 2 (d), p. 262). Code Authority shall submit to Administrator recommendations for changes in provisions of Code as relate to plant hours.

336—*Covered Button* (Art. II, Pars. 5 and 7, pp. 91–92). No member nor any employee shall work in shop or factory at manufacturing operations after the regular hours to be set up by Code Authority and approved by Administrator.

442—*Lead* (Art. VI, Sec. 6, Par. (g), p. 372). Code Authority to recommend to Administrator such measures as have been voluntarily agreed upon covering production control.

B4 RESTRICTIONS OF OPERATING TIME

1—*Cotton Textile* (Art. III, p. 16). Shall not operate productive machinery more than 2 shifts of 40 hours each week, a total of 80 hours per week.

3—*Wool Textile* (Art. IV, p. 39). No employer shall operate any comb or any spinning spindle or any loom or any knitting machine for more than two shifts of 40 hours each per week, a total of 80 hours per week.

5—*Coat and Suit* (Art. III, p. 4). 1 shift of 35 hours per week. Hours are from 8:30 a.m. to 4:30 p.m. with one hour for lunch.

6—*Lace Manufacturing* (Art. III, p. 2). Productive machinery shall not operate more than two shifts of 40 hours each per week, a total of 80 hours per week.

7—*Corset and Brassiere* (Art. IV (a), p. 2). Maximum hours of productive operation for any plant shall be 40 hours per week and no plant shall operate in excess of 5 days in any week.

15—*Men's Clothing* (Art. IV, p. 232). Shall not operate productive machinery more than one shift of 36 hours per week.

16—*Hosiery* (Art. IV, Par. 6, p. 242). Productive operations of a plant shall not exceed 2 shifts of 40 hours each per week, a total of 80 hours per week. Work week except for dyeing shall not exceed 5 days of 8 hours each, a total of 40 hours per week.

18—*Cast Iron Soil Pipe* (Art. VI, p. 262). Shall not operate productive equipment for more than 27 hours per week.

19—*Wall Paper Manufacturing* (Art. III, p. 2). Each manufacturer shall be limited to two 8-hour shifts per day.

23—*Underwear and Allied Products Mfg.* (Art. III, p. 318). Sewing machines shall not be operated more than one shift of 40 hours per week. Knitting shall not be operated more than 2 shifts of 40 hours each per week, a total of 80 hours per week.

27—*Textile Bag* (Art. III, Par. 2 (b), p. 366). No production machinery shall be operated for more than 2 shifts of 40 hours each per week, a total of 80 hours per week.

36—*Glass Contained* (Art. VI, Schedule "C," pp. 463–467). No plant shall operate in excess of 6 days per week.

48—*Silk Textile* (Art. III, Par. 1, p. 2). Shall not operate productive machinery more than 2 shifts of 40 hours each per week, a total of 80 hours per week.

51—*Umbrella* (Art. III, Par. 2, p. 2). Manufacturers shall not work more than 1 shift of employees per week. Employees shall not work in excess of 5 days in any one week or 40 hours per week or 8 hours per day.

53—*Handkerchief* (Art. III, Par. 2, p. 2). No machine shall be operated in manufacture or embellishment of handkerchiefs on a schedule of more than 2 shifts of 40 hours each in any one week, a total of 80 hours per week.

54—*Throwing* (Art. II, Par. (a) 1, p. 648). Operation of throwing machinery in any one week limited to between hours of 6 a.m. Monday and 7 a.m. of following Saturday—also to 2 full working shifts of 40 hours each, a total of 80 hours per week.

Throwing (Art. III, Par. 1, p. 650). Code Authority recommend to Administrator further limiting of working hours.

64—*Dress Manufacturing* (Art. III, Pars. 1 and 4, p. 88). Operations limited to 1 shift in any one day and employees in mechanical processes limited to 35 hours and 5 days in any one week.

78—*Nottingham Lace Curtain* (Art. III, pp. 256 and 257). Productive machinery shall not operate more than 2 shifts of 40 hours each per week, a total of 80 hours per week. Lace curtain weavers restricted to work only from Monday through Friday (5 days).

79—*Novelty Curtain Draperies, Bedspreads and Novelty Pillow* (Art. III, Par. 4, p. 2). One shift of 40 hours per week for machinery.

90—*Funeral Supply* (Art. III, Pars. 1 and 2, p. 425). No employer shall operate more than 2 shifts of 40 hours each per week, a total of 80 hours per week.

118—*Cotton Garment* (Art. V, p. 94). Productive machinery limited to one shift of 40 hours per week (except cutting machinery).

119—*Newsprint* (Art. III, Par. 1, p. 106). Paper machines, limited to 144 hours per week.

125—*Upholstery and Drapery Textile* (Art. III, Sec. 4, p. 267). Loom operation limited to 2 shifts of 40 hours each per week, a total of 80 hours per week.

135—*Cigar Container* (Art. III, Par. 2 (d), p. 437). Production machinery limited to 1 shift of 8 hours per day except during peak demand, then $9^1/_2$ hours per day (September 10–December 10).

149—*Machined Waste Manufacturing* (Art. III, Par. 2, p. 611). Production machinery limited to 1 shift of 40 hours per week.

156—*Rubber Manufacturing—Rainwear Division* (Art. IV, Part A, Sec. 1, p. 115). Operation of establishments is limited to 40 hours per week.

157—*Hair Cloth Manufacturing* (Art. III, Par. 5, p. 123). Productive machinery limited to 1 shift of 40 hours per week.

164—*Knitted Outerwear* (Art. III, Par. (d), p. 203). Limitations are: Productive machinery, 2 shifts of 40 hours each per week, or a total of 80 hours per week; other machinery, 1 shift of 40 hours.

166—*Wax Paper* (Art. III, Par. 4, p. 236). Plant operation limited to 144 hours per week.

172—*Rayon and Silk Dyeing and Printing* (Art. III, Pars. 5 and 6, pp. 315–316). Limitations are: (1) Productive machinery, 80 hours per week; (2) plant operations, 96 hours per week; (3) exception: velvet processing, 120 hours per week; (4) working hours, 6 a.m. Monday to 6 a.m. Saturday.

175—*Medium and Low Priced Jewelry Manufacturing* (Schedule G, Sec. 2, p. 372). Machine Chain Division—Chain machinery limited to 40 hours per week.

188—*Velvet* (Art. VIII, Par. 1, p. 546). Productive machinery operating limited to 2 shifts of 40 hours each per week, a total of 80 hours per week.

190—*Paper Stationery and Tablet Manufacturing* (Art. III, Sec. 4, p. 563). (1) No plant operation on Sunday; (2) female plant, mill or factory employees not permitted to work between 7 p.m. and 7 a.m.

194—*Blouse and Shirt Manufacturing* (Art. II, Pars. 1, 4, 5, 6, 7, p. 611). Employees in mechanical processes, 7 hours per day. Code Authority may designate hour before which work shall not begin and hour after which work shall cease. One shift of employees per day. Code Authority may allow limited overtime.

211—*Robe and Allied Products* (Art. III, Par. 5, p. 217). Machine operation limited to 1 shift of 40 hours per week.

212—*Drapery and Upholstery Trimming* (Art. III, Par. 4, p. 230). Productive machinery operation limited to 2 shifts of 40 hours each per week, a total of 80 hours per week.

214—*Slit Fabric Mfg.* (Art. III, Par. 8, p. 250). One shift of employees in any one day. No employee shall work in excess of eight hours per day.

217—*Dental Laboratory* (Art. III, Sec. 7, p. 288). Limitations are: (1) 52 hours in any week; (2) hours of opening and closing.

220—*Envelope* (Art. VI, Pars. 1 and 2, p. 338). Plant operation limited to 40 hours per week.

226—*Light Sewing Industry Except Garments* (Art. III, Par. 4, p. 408). Not operate more than two shifts of 40 hours each per week, a total of 80 hours per week. *Mattress Cover Division* (Art. III, Par. 1, p. 416). Not operate more than one shift of 40 hours per week.

227—*Wet Mop Manufacturing* (Art. III, Par. 3, p. 430). Production machinery limited to two shifts of 40 hours each per week, a total of 80 hours per week.

235—*Textile Processing* (Art. II, Par. 4, p. 544). Cone winding machines, reels, through-tube cap machines and parallel-tube winding machines used in the production of cotton mercerized yarn only shall be subject to the limitation of hours of operation provided for similar machinery in Code for the Cotton Textile Industry.

253—*Animal Soft Hair* (Art. III, Par. 2, p. 100). Recognized hours of work shall be between 8 a.m. and 5:30 p.m. with one hour for lunch.

256—*Schiffli, The Hand Machine Embroidery and Embroidery Thread and Scallop Cutting Industries* (Art. IV, Par. 1 (a), p. 143). Limitations are: (1) One shift of 40 hours per week; (2) time of work prescribed.

259—*Hat Manufacturing* (Art. II, Par. 5, p. 195). One shift per day in finishing department in manufacture of felt hats and in sewing, pressing, and blocking departments in manufacture of straw, Panama, and other body hats.

262—*Shoulder-Pad Manufacturing* (Art. III, Par. 8, p. 236). One shift of employees in any one day.

Shoulder-Pad Manufacturing (Art. III, Par. 1, p. 235). No employee shall be permitted to work in excess of 8 hours in any 24-hour period.

276—*Pleating, Stitching and Bonnaz and Hand Embroidery* (Art. III, Par. 1, p. 409). Hours of work shall be 8:45 a.m. to 4:45 p.m. with one hour for lunch.

281—*Laundry Trade* (Art. III, Par. 4 (a), p. 494). No member of the trade shall be open for the production of laundry service between the hours of 10 p.m. and 6 a.m. or on Sunday.

283—*Ready-Made Furniture Slip Cover Manufacturing* (Art. III, Pars. 2 and 3, p. 531). A normal work week shall not exceed 6 days. No member of the industry shall operate more than one shift.

303—*Cordage and Twine* (Art. VI, Par. 7, p. 263). Operation of productive machinery limited to 2 shifts of 40 hours each per week, a total of 80 hours per week.

309—*Solid Braided Cord* (Art. VI, p. 355). Productive machinery shall not be operated for more than 2 shifts of 40 hours each per week, a total of 80 hours per week.

312—*Narrow Fabrics* (Art. III, Par. 4, p. 391). Operation of productive machinery limited to 2 shifts of 40 hours each per week, a total of 80 hours per week.

324—*Textile Print Roller Engraving* (Art. III, Sec. 1, p. 542). Hours of work only between 7 a.m. and 7:30 p.m.

368—*Print Roller and Print Block Manufacturing* (Art. III, Sec. 1, p. 544). Hours of work only between 8 a.m. and 5 p.m.

393—*Soft Fiber Manufacturing*. Productive machinery not to be operated in excess of 80 hours in any one week.

400—*Celluloid Button, Buckle, and Novelty Manufacturing* (Art. III, Par. 10, p. 371). Plant operations are limited to 1 shift of 40 hours per week.

408—*Undergarment and Negligee* (Art. III, Pars. 1 and 2, p. 499). (1) No manufacturing employee shall work in excess of $7\frac{1}{2}$ hours in any 24-hour period; (2) one shift of employees in any one day.

436—*Fur Manufacturing* (Art. III, Par. 3, p. 271). No employee engaged in manufacturing production, repairing, remodeling of fur articles shall be permitted to work on any Saturday or Sunday nor shall any employee be permitted to perform such work before 8:30 a.m. or after 4:30 p.m.

457—*Cap and Cloth Hat* (Art. III, Sec. 2, p. 197). No manufacturing operations on Saturday and Sunday except in a week having a religious or legal holiday—no more than five days a week in any event.

494—*Merchant and Custom Tailoring* (Art. III, Sec. 1, p. 52). Hours of labor from 8 a.m. to 12 m. and 1 p.m. to 5 p.m. and no Sunday work.

B5 RESTRICTIONS ON NUMBER OF MACHINES PER OPERATOR

16—*Hosiery* (Art. VI, Par. 3, p. 244). (1) All full fashioned knitting machines shall be operated on a single-machine basis; (2) knitter not to operate more than two full fashioned legging machines.

54—*Throwing* (Art. IV, Par. 3, p. 651). Recommendation *shall* be made as to number of spindles to be operated by an employee on different classes of yarn.

125—*Upholstery and Drapery Textile* (Art. III, Sec. 5, p. 267). No employee is required to operate more machines or perform duties in addition to those prevailing on July 1, 1933.

164—*Knitted Outerwear* (Art. VIII, Par. (c), p. 205). Maximum machine load of employees as approved or prescribed by President.

256—*Schiffli, The Hand Machine Embroidery and Embroidery Thread, and Scallop Cutting Industries* (Art. IV, Par. 3, p. 144). Pending further recommendation, no member shall require any employee to tend a greater number of machines than customarily tended in such plant in work of July 1, 1933 (*stretchouts*).

B6 RESTRICTIONS ON PRODUCTIVITY

1—*Cotton Textile* (Schedule A, Par. 5, p. 22). No employee shall be required to do any work in excess of practises on July 1, 1933 (*stretchouts*).

3—*Wool Textile* (Art. III, p. 39). No employee required to do any work in excess of practises prevailing on July 1, 1933 (*stretchouts*).

15—*Men's Clothing* (Art. II, Par. (f), p. 232). No increase in production or work of employees shall be required.

16—*Hosiery* (Art. V, Par. 7, p. 243). No increase in amount of production of work required over practises prior to July 15, 1933.

23—*Underwear and Allied Products Manufacturing* (Art. II, Par. 3 (d), p. 317). No employee required to do work in excess of practises prevailing July 1, 1933 (*stretchouts*).

78—*Nottingham Lace Curtain* (Art. VI, pp. 257–258). No employee required to do work in excess of practises prevailing July 1, 1933 (*stretchouts*).

79—*Novelty Curtain Draperies, Bedspreads and Novelty Pillow* (Art. V, Par. 7, p. 2). No manufacturing employee required to do work in excess of practise prevailing July 1, 1933 (*stretchouts*).

112—*All Metal Insect Screen* (Art. III, Par. 6, p. 2). No increase in amount of productive work required of employees.

125—*Upholstery and Drapery Textile* (Art. III, Sec. 5, p. 267). No employee is required to operate more machines or perform duties in addition to those prevailing on July 1, 1933 (*stretchouts*).

140—*Waterproofing, Dampproofing, Caulking Compounds, and Concrete Floor Treatment Manufacturing* (Art. V, Par. 9, p. 502). No increase in amount of production work required of employees.

143—*Wool Felt Manufacturing* (Art. V, Par. 8, p. 540). No employee is required to do any work in excess of practise prevailing July 1, 1933 (*stretchouts*).

157—*Hair Cloth Manufacturing* (Art. V, Par. 7, p. 124). No employee is required to do any work in excess of practise pravailing July 1, 1933 (*stretchouts*).

183—*Household Ice Refrigerator* (Art. IV, Par. 6, p. 477). No increase in amount of production work required of employees.

212—*Drapery and Upholstery Trimming* (Art. V, Par. 9, p. 231). No manufacturing employee required to do any work in excess of practise prevailing July 1, 1933 (*stretchouts*).

312—*Narrow Fabrics* (Art. V, Par. 9, p. 393). No manufacturing employee shall be required to do any work in excess of practise prevailing July 1, 1933 (*stretchouts*).

496—*Industry of Collective Manufacturing for Door-to-Door Distribution* (Art. V, Sec. 10, p. 99). No employer shall effect a per capita increase in production by such means as the "*Stretchout.*"

Courtesy Chevrolet Motor Co.

FUNDAMENTALS *for* RECOVERY *in the* DURABLE-GOODS INDUSTRIES

By GEORGE H. HOUSTON

PRESIDENT, BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA, PA.

I HAVE been asked to address you today on economic recovery and the conditions essential to it, probably the subject most in the minds of men throughout the world at this time. It is particularly fitting that engineers should give extended consideration to these present-day problems as they may be said to be largely responsible for their origin.

The economic difficulties from which the world is suffering today arise largely from the fact that, beginning with the introduction of cheap power, the physical sciences and the mechanical arts growing out of them have developed more rapidly than the social sciences and the arts of government, organization, and management, leaving man in the anomalous position of creating things he does not know how to control. Man's ability to organize and function effectively along economic lines has not grown as rapidly as his capacity to produce the material equipment of civilization. These problems of organization will continue with us for the indefinite future, and, if not dealt with wisely, may well constitute a limitation upon civilization's progress. There is no group which should consider these matters more thoughtfully, nor endeavor more honestly to assimilate their significance, than the engineers who have been so effective in the development and application of our physical sciences. If we can learn to organize society effectively as well as continue to master the forces of nature, our civilization may continue to almost unlimited accomplishments of physical well-being and intellectual development. If we are unable, however, to develop a social organization competent to use and control the mechanical facilities our engineers have created in the past and will create in the future, we will reach finally such social confusion as to render further material progress impossible and stabilized existence improbable.

INDIVIDUALISM VS. COLLECTIVISM

There have long existed in the minds of men two alternative theories upon which society may be organized: First, individualism, in which the facilities of production, distribution, and living are owned and controlled by the private individual; the other, collectivism, in which these facilities and particularly those of production and distribution are owned or controlled wholly or in large part collectively—that is, by the state or its agencies.

Most of the civilized countries in the world have reached their present state of economic and social development under an individualistic form of social organization, although, as economic conditions have become more complex, there has been a steady trend in each of these countries toward the collective performance of certain economic functions. This trend should not be discouraged or opposed so long as functions thus carried on collectively are better performed and render a better and more adequate service to the community as a whole than if they were performed in an individualistic manner. Collectivism should not be condemned merely because it is collectivism, but the burden of proof as to its efficacy and value to society should be placed upon its sponsors, and it should not be accepted and applied any further than actual experience warrants. This is an excellent sample of a situation in which the scientific method of experimentation is vitally needed. The problems are so vast, the issues so vital, that thoughtless mass action or experimentation on a nation-wide scale is perilous in the extreme.

NATIONAL ECONOMIC PLANNING

In recent years, and particularly since the War, there has been a marked tendency on the part of various European countries to seek a solution for their acute economic problems arising from the War by changing the form of their social organization from one of individualism to one of comprehensive collectivism. Have they improved their condition? Certain other civilized countries are at a point where a fundamental decision must be made shortly as to which of these two theories of social organization will be emphasized by them in the future. This decision, once made by a given political group or nation, will dictate to a large extent the character and direction of the ensuing steps toward recovery to be taken by it and ultimately will determine the extent of such recovery, depending upon the effectiveness of the form of social organization adopted and of the recovery policies undertaken and carried out by it. In the communistic Soviet Union, in Fascist Italy, and in Nazi Germany we see developing different forms of the collective organization of society. In America, which has been, up to this time, the stronghold of the type of individualism developed by the Nordic races, we are faced today with this question, not as a clear-cut, well-defined issue between these two theories, but rather as an attempt to discredit the principles of individualism as manifested in our capitalistic practises, in favor of the principles of collectivism as manifested in vast plans of centralized control of the facilities of production and distribution, and even, in some instances, of the facilities of living. These principles of collectivism find an expression in the concepts of national economic planning as now being advocated by some of our leaders.

By national economic planning I mean the formulation, by a centralized group or groups, under the direction and control of government, of plans for the balancing of the production of goods and services, including facilities for such production,

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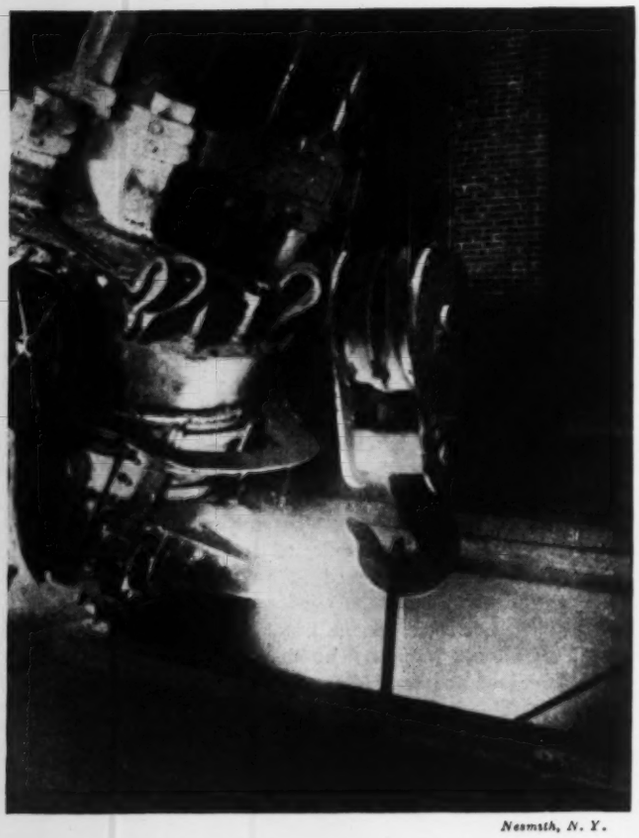

Nesmith, N. Y.

with their consumption demand, and the carrying out of these plans through control of the facilities of production and distribution, including provision of such facilities, by centralized governmental regulation. A planned economy is essentially a collective economy and planned production is essentially planned consumption. Lionel Robbins, professor of economics in the University of London, in a recent treatise on the depression has well said

> .... planning involves central control. And central control excludes the right of individual disposal. Nothing but intellectual confusion can result from a failure to realize that planning and socialism are fundamentally the same. Now the leaders of opinion want planning. But do they know what they mean? Have they really faced what planning involves? ... It should be clear that the problem of planning is not to be solved by giving each industry the power of self-government (that is, restriction of entry and production). This is not planning; it is syndicalism. It merely extends to whole industries the right to make plans for themselves similar to the right already enjoyed by individual entrepreneurs... A planned economy must be planned from the center. This is the only intelligible meaning which can attach to the concept.... The system would require the complete regimentation of individuals considered as producers. As consumers they could choose between the commodities available. But on the choice of commodities to be produced they would have relatively little influence. They would have to take what it was decided to produce. And what it was decided to produce would be the resultant, not of the conflicting pulls of prices and costs, but of the conflicting advice of different technical experts and politicians with no objective measure to which to submit the multitudinous alternatives possible.

National economic planning as I have defined it must not be confused with the procurement and dissemination, on a national basis, of factual information concerning business which may be made an important medium for guiding the business activities of the country. It is axiomatic that if different people of a given intelligence work from the same viewpoint and information their conclusions will be more or less similar. It is essential, however, that such information be factual and not artificially colored by public policy.

The first essential to recovery in America is to determine whether we shall recover under the individualistic economy of capitalism or under the collective economy of national economic planning. The two are essentially antagonistic and recovery under both of them cannot be carried on simultaneously, regardless of the extent to which recovery may be attained under either of them separately. National economic planning in America has involved so far four comprehensive programs:

(1) The regulation of agriculture through the Agricultural Adjustment Act, the Bankhead Act, and the Tobacco Control Act.

(2) The regulation of industry through the National Industrial Recovery Act.

(3) The regulation of the supply of capital and credit to private enterprise through the Securities Act of 1933 and the Securities Exchange Act of 1934.

(4) The procurement of social security through steps not yet concretely determined in statutory form.

Depression may be said to be caused by serious maladjustments primarily between the national income on the one hand and debt and taxation on the other; between the volume of production of particular goods and the demand for them; and between the price of particular commodities and the general price level. Assuming that man has the ability to deal with the vast intricacies of centralized planning and administration of our economic life, it is well to test the effectiveness with which this centralized control has restored these essential balances, so as to afford a renewed exchange of goods and services resulting in renewed employment, which is the cure for depression. Has the regulation of agriculture and the regulation of industry been effective in this direction? Are we producing and consuming more goods and services, thereby raising the standard of living of our people? Are we engaging a larger portion of our population in gainful employment outside of the employment created by government expenditures financed by expanding government debt? Has the regulation of the flow of capital into private business resulted in a revitalizing of enterprise and a renewed desire on the part of the entrepreneur to seek and risk capital in the hazards of new enterprise? Your president, Mr. Flanders, has recently said that "In business risk lies social safety." If this is true, and I believe it is, then to the extent that commercial enterprise is undertaken, social security is increased, and vast plans for procuring social security through artificial stabilization of the economic life of the country become unnecessary and unwarranted.

Have these plans, undertaken upon a national scale, accomplished these objectives? I hazard the answer that they have not and that they will not, for I believe that these objectives cannot be attained in this manner, at least without subjecting the individual to a degree of collective dictation that will be unacceptable to him. Assuming that the individual might accept such dictatorship, I still do not believe that these objectives can be attained through collectivism of this character, due to man's inability to grasp, assimilate, and solve problems so vast and intricate as those involved in national economic planning. If, as I have indicated, the present economic difficulties of the world have arisen largely from man's present lack of ability to master the existing problems of social organization, this ability will not be increased by multiply-

ing almost to infinity the size and the intricacy of these problems.

The present safety and future progress of civilization lie not in centralized planning and regulation through autocratic dictatorship, but rather in the principles of self-determination, local autonomy, and decentralized control upon which the English-speaking people have built their progress for the past one thousand years and more. I am confident that the future progress of America lies in the continuation of the social organization comprehended within the term "individualism," restricted and safeguarded in such a manner as to prevent the organized exploitation of one individual or group or portion of the population by another, and in the restoration and revitalizing of private enterprises in the field of production and distribution of goods and services.

CONSUMPTION AND DURABLE GOODS

In general, goods and services are of two characters: (1) Those consumed currently in the processes of living, such as food, clothing, tobacco, and gasoline; and (2) those used in the processes of rebuilding and developing the facilities of the country, such as houses, house furnishings, automobiles, public works, and the permanent facilities of production, transportation, and commerce. The first group we call ephemeral or consumption goods and the second group we call durable goods.

Consumption goods, because they retain no substantial utility value after initial use, are not available as collateral for credit after initial use, and, therefore, in general, must be paid for in cash at the time of use. Such cash must of necessity be provided from current income, otherwise their acquisition would have to be financed by the incurring of debt secured by other collateral. Durable goods, on the other hand, retaining a substantial utility value after initial use, are available for credit during their useful life. Man has learned this by experience, and, as a result, has become accustomed to the purchase of these goods by the use of credit, paying for them by savings accumulated during the useful life of such goods.

Consumption goods, being more or less of a necessitous character and being destroyed with initial use, possess a relatively uniform volume of demand, this demand being in terms of about 105 per cent of normal at the peak of a boom and in terms of 75 to 80 per cent of normal at the bottom of a depression. Durable goods, being consumed more or less slowly by use, possess an elastic life. Therefore, although the demand for the use of existing durable goods is relatively uniform, the demand for new durable goods is highly variable, ranging from 150 to 200 per cent of normal at the peak of a boom to 25 to 50 per cent at the bottom of a depression. By maintenance or by reducing the standard of quality, durable goods may be made to last almost indefinitely. For instance, the average life of houses in America is, say, 25 years, while one city in Germany boasts that it has not had a new house built within its borders for 150 years. The houses in Germany are not six times better than those in America, but are kept in condition indefinitely, with all of their obsolescent features, by continual maintenance.

Durable goods fall into three distinct classifications:

(1) Durable goods for personal use, such as houses, house furnishings, and passenger automobiles.

(2) Public property, such as streets, roads; municipal improvements, like sewage systems, water works, publicly owned electric plants; great public works, such as the Panama Canal, Boulder Dam, the Tennessee Valley development; and facilities of government, such as public buildings, post offices, and facilities of Army and Navy.

Elizabeth R. Hibbs, Phila.

(3) Capital goods, including facilities of production, transportation, and commerce, created primarily for the production of goods and services and the earning of a profit upon the investment.

The proponents of the theory of oversaving and underconsumption advance the viewpoint that the spending for consumption goods, paid for out of current income, is inadequate, because too large a portion of the aggregate national income is accumulated in savings through (1) distribution of an excessive portion of the national income as a return on property, and (2) excessive saving on the part of earners due to a sense of personal insecurity. These proponents believe that by readjusting the distribution of the national income so as to reduce the return on property and by guaranteeing to the individual in some unstated manner permanent security of income, there will be a large diversion of spending from the field of durable goods to those of ephemeral consumption goods and personal services, thereby taking up the slack of unemployment, permanently maintaining a balance between earning and spending and between production and consumption; thereby perpetuating a condition of prosperity.

In advancing these theories they fail to deal with a number of factors which require consideration:

(1) The savings actually spent are largely for durable goods for personal use or for general use as public property, and only a minor portion of such savings, ranging from 35 to 45 per cent of the total, is for capital goods.

(2) They fail to substantiate their claim that the rate of rotation of capital goods within the country is up to the point of greatest overall economy. In fact, there are many instances of capital goods for which the rate of rotation has been so slow as to take many years to apply effectively, in the practise

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of a given art, the mechanical improvements made in the equipment available for use in that art. An instance of this character is that of motive power on American railroads which has been rotated at so slow a rate that the greater part of the existing equipment is and has been mechanically obsolete for years. This condition exists largely because of the loss of buying power on the part of the railroads and not because of lack of consciousness of the obsolescence factor. When facts such as these are readily available, claims that excess of investment resources is forcing, ruthlessly, the rotation of investment in capital goods to the detriment of the standard of living of the people, through the excessive destruction of savings, need to be substantiated by a more adequate presentation of proof.

(3) Another point which is largely ignored is the uncertainty of individual security and man's inability, so far in the history of the race, to procure such security through mass action, with the result that there is an inherent desire on the part of the individual to procure his own security by the accumulation of his own property.

Referring to the recent able presentation by David Cushman Coyle of the oversavings theory as applied to capital goods, I do not believe the American people will accept his viewpoint when he says, "The simplest and most painless way of recirculating savings without the formation of debt is for those who own the savings to change their minds and spend the money in having a good time." I am inclined to the opinion that the American people will continue to save and to invest their savings in the durable property of the country.

While we hear much of the New Deal, I believe that the experience of the human race, gained through the ages, still applies. Everything that has been right is not now wrong and everything that has been improvident or irresponsible is not now right. This is not the true significance of the New Deal, which rather should be interpreted as a striving after greater social justice, without the abandonment of any of the proved facilities of civilization nor the rejection of its lessons.

I believe that the standard of civilization of a given social order is largely dependent upon the volume of durable goods used by its people and the rapidity with which they rotate—that is, the rapidity with which they are produced, used, and replaced by new durable goods. I have likened this rate of turnover to the metabolism of the human body as a measure of the vitality of a civilization. It has reached a very high point in America—higher, in fact, than in any other country at any time, anywhere, in the world's history. I personally would regret exceedingly to see this rate of turnover or the expansion in the volume of durable goods in use at any one time slowed down or discouraged in any manner, as to do so would reduce our standard of living on the one hand and the proportion of our population to be gainfully employed on the other.

At no time in the world's history has any country which produced its own food products ever employed so large a proportion of its population in gainful occupation outside of agriculture as has America. This accomplishment is due almost entirely to the rapid accumulation of savings and their free investment in durable goods of relatively short life, that is, possessing a rapid rate of rotation.

During the ten years ended with 1930, the volume of savings flowing into investment in new securities exclusive of refundings of every kind, averaged about $3,600,000,000 per annum; in 1931 this had dropped to something less than $1,600,000,000 due to the liquidation then in process. But by 1933, this volume had shrunk to only $160,000,000, or about 4 per cent of the annual average of the decade of the 20's. For the 12 months ended October 30, 1934, this volume was only $158,000,000, so that no improvement has been seen to date.

This small volume of investment is not due to lack of resources but to lack of willingness on the part of enterprise to issue securities, incur debt, or assume obligations for the future. Until this attitude is modified, there will be a great lack of new private enterprise, hence the necessity to substitute public enterprise for private in an effort to restore employment. It will be found, however, that public enterprise will be quite inadequate, and that private enterprise, with confidence restored through the removal of existing obstacles, will be depended upon in the final analysis for recovery, which will be effected through recognition of the place of durable goods in our economic life. One-half of existing unemployment lies in the field of durable goods, principally in construction. It is coming to be more and more recognized that recovery must be created through reemployment in these fields which in turn will also create further employment in the service industries and in the consumption-goods industries. The program of the Federal Housing Administration in modernizing existing housing and mercantile facilities and in establishing a sound mort-

gage system for financing housing is a most important step in the right direction.

Revival of private enterprise in durable goods is possible, however, only by correction of the existing disparities and by encouragement to private business. The disparities which may be said to have contributed greatly to the origin of the depression and to its continuation have been substantially alleviated in some directions, for instance, by the devaluation of the dollar, but continue to exist in other directions, and, in some instances, in aggravated form. The most serious of these situations lies in the effect upon industrial activity of the National Industrial Recovery Act. The administration of this act through codes of fair competition has resulted in the shortening of working hours and the raising of rates of pay to a point where the increased costs of production and resulting prices of manufactured products have tended to increase rather than reduce the disparity previously existing between the price of manufactured products and the general price level.

Price-fixing and price-regulating provisions have been permitted in many codes, but when applied have met with such vigorous public opposition that serious consideration is now being given to their abandonment. This will tend to a certain extent to depress prices by the restoration of competition where it had been suspended. With the retention, however, of the high costs and rigid labor conditions created by codification, what will be the effect upon profit and the incentive necessary for the renewal of forward-looking enterprise in private business?

The industrial recovery program made the mistake of raising costs of manufactured products prior to the development of a renewed demand for such products so that today many lines of goods are costing more than they did at the peak of 1929, although the present volume of production is not more than 25 or 30 per cent of that period. The demand for durable goods is essentially an induced demand arising from the expectation of a profit from the use of such goods or from satisfaction in the enjoyment of their possession. Each of these incentives disappears rapidly in the face of high prices for such goods in relation to the general price level. This particular instance of economic planning is facing, now, the almost insuperable difficulty of correcting this disparity. The possibility of effecting this correction will not be improved by a further shortening of working hours in these depressed industries with a corresponding further increase in wage rates, costs, and prices.

Prosperity means a free exchange of goods and services between different portions of the population, for instance, between the producer of agricultural products and the producer of manufactured products. This free exchange can only be procured when the prices of these commodities are properly balanced, one against the other. Not only must the relative price level be considered but also the relative volume of goods and services being offered for sale by each group. If agricultural prices are raised because of a shortage of agricultural products, while the unit price may be very satisfactory, the aggregate buying power of the farmer may still be so low as to prevent him from buying a sufficient quantity of the products of manufacture to keep the factory worker normally employed. Every effort must continue to be made to restore the buying power of the farmer with relation to that of the urban dweller. The industrial recovery program has not made progress in this direction.

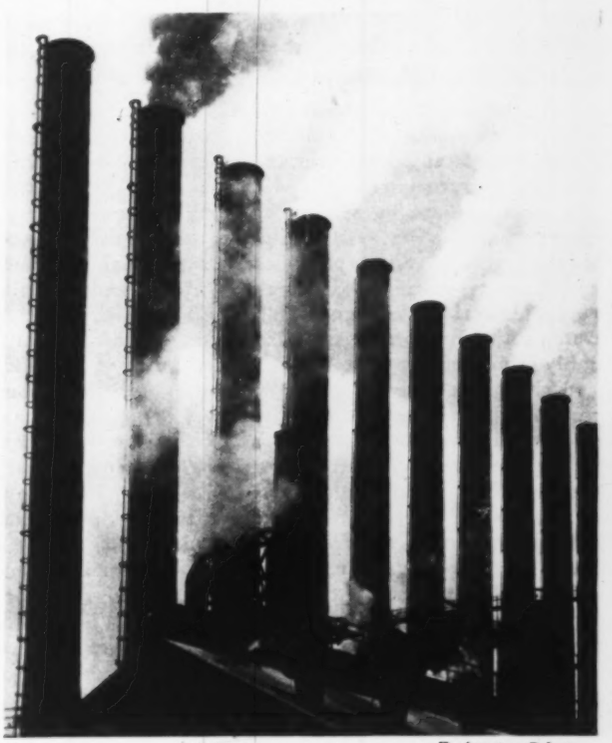
In this connection it is well also to consider what industry's real purpose in society should be and the extent to which this program recognizes this purpose. Industry may be said to perform three functions:

(1) Production of goods and services desired by the people.

(2) Provision of gainful employment for those who desire it.

(3) Provision of an opportunity for investment of the savings of the people in such a manner as to obtain therefrom an income and to provide a reasonable conservation of such savings until they are again wanted by the owner.

Undue emphasis upon the last of these functions, that is, safety of investment and rate of return, will invariably create monopolies for the purpose of extracting from the national income all the traffic will bear for the benefit of the investor. The marketing provisions of some codes of fair competition are undoubtedly of this character. Undue emphasis upon the second of these functions will, in like manner, create monopolies for the benefit of those gainfully employed. This result is already manifest in certain codified industries. The first of these objectives has always been the one emphasized in American life up to this time. Anything interfering with the production of goods and services has been considered to be contrary to the public interest. A calm consideration of the industrial recovery program must lead to the conclusion that it does not and will not stimulate the production of the maximum quantity of goods and services, but tends rather to a restriction of such production through high costs and prices, and through code provisions restricting quantity of output, new equipment, and other interferences with the free expression of private initiative and enterprise. These are all facts that require consideration in dealing with the future of the National Industrial Recovery Act. The more they are considered, the more nearly the American people will come, I believe, to the conclusion that emphasis upon the production of goods and services through channels of individual enterprise must continue to be the essential keynote of our national economic policy as it has been in the past, and that competition carried on under necessary statutory safeguards must



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continue to dominate the industrial system of the country.

There is a substantial body of opinion, however, which believes that certain industries, such as those procuring, fabricating, or refining and distributing natural resources, should be allowed to market their products under agreements that would constitute a restraint of trade, thereby violating the provisions of the anti-trust laws. There is something to be said for the propriety of such a plan if confined to the voluntary codification of industries engaged in the conservation of natural resources or of essential industries that can demonstrate that they cannot live otherwise, if there are any such, providing that all such arrangements are made voluntarily by the industry concerned and are carried out under full governmental supervision in the public interest. These instances should be the exceptional and not the usual methods of doing business.

CONTROL OF CAPITAL AND CREDIT

Turning to the control of capital and credit, we see vast changes effected within the past year which likewise require critical scrutiny to determine their place in American life. We see a mounting government debt, an unbalanced budget, and a devalued monetary unit. We see the Federal Reserve System subordinated to the Treasury Department. The credit system of private business is being subordinated to the credit needs of government. Such subordination may be essential so long as the credit needs of government continue to mount in present proportions, but are such conditions conducive to the restoration of employment through renewed private investment in the securities of private business? The needs of business for capital and credit are supplied by two distinctly separate financial activities:

(1) Deposit banking, having to do with the custody of the working assets and liquid funds of the country and their lending for working-capital purposes.

(2) Investment banking, having to do with the supplying to industry of its permanent capital needs through the issuance and distribution of securities, these being purchased in the final analysis by the accumulated savings of the country.

The deposit-banking situation in this country leaves much to be desired, being made up of a national banking system supervised by the Federal Government and 48 separate state banking systems, each supervised by a different state, independent of the national banking system. There is no question but what these conflicting systems should be consolidated and greatly simplified. Some proponents of national economic planning are advocating that this reorganized system be built around a central bank, owned and operated by the Federal Government, thus permanently socializing credit and inevitably subordinating the private-credit resources of the country to the needs of government. There is little doubt but that a banking system, permanently headed by a government-owned central bank, would do irreparable injury to the future growth of the country and to the further expansion of private business. What is needed is a system of national banking, privately owned and operated, under effective and comprehensive supervision of the Federal Government.

Except as this movement of credit and savings into construction and other forms of durable property is resumed, there can be no permanent recovery in employment. Will private enterprise seek such capital and assume the liabilities involved in the far-reaching but vague provisions of the Securities Act and the Securities Exchange Act? Business welcomes such regulation of the securities markets as is essential to prevent abuses and excessive speculation in securities, but it does not approve of regulation that is so repressive as to discourage private enterprise from satisfying its capital needs in such a manner as to stimulate growth and forward planning. Except as these laws are administered in such a manner as to encourage private enterprise to seek and use this capital, being amended where necessary to permit of such administration, we will not have a resumption of normal investment in the securities of business.

THE PROBLEM OF SOCIAL SECURITY

The final phase of economic planning, now under consideration, has to do with the removal of the hazards of life for the individual and with the establishment of safeguards against such hazards in such a manner as to assure to each individual a permanent livelihood of a certain minimum standard, come what may. The world has aspired to this objective for many centuries. Plato dreamed of it. Its desirability will be accepted today by every thoughtful person, except as it creates such a static society as to destroy the dynamic forces of individual initiative. If we can accomplish it now, with these limitations, by one bold stroke, let us do so, but if this program fails of its accomplishment and instead merely shackles business with further interferences and burdens, then our later condition will be worse than our present one of continuing hazard which, at least, has made us what we are.

The essence of social security is continuity of the greatest possible volume of gainful employment. The amount of gainful employment possible at any one time is not controlled, to any marked extent, by the employer but rather by his market, and by conditions existing within that market. Industry is forever contending with these conditions in an effort to exist. To burden industry in this contest with the task of compensating the unemployed, when idleness is forced upon them, particularly during periods of depression, is merely to raise the cost of the products of industry to a place where a lesser volume of such products can be absorbed by the population as a whole. Industry cannot absorb such burdens except as they are passed on in increased costs and prices. To burden industry further by punitive measures undertaken to force regularity of employment will result, in the long run, in less employment, thereby defeating its own end.

If we agree that the proper objective of industry is the production of goods and services, then why not free industry from all other burdens except its proper participation in the tax burdens of government, and make industry directly the servant of society to produce its goods and services in the largest possible volume at the lowest reasonable cost, letting society as a whole provide the individual with the greatest possible degree of security which, at any given time, it is capable of furnishing.

It is not in the public interest for the products of industry to be increased in price, and the user of such products to be taxed indirectly, for the purpose of social security in a way that disguises the extent and direction of expenditures made for such purposes; rather society should face these problems squarely and deal with them frankly upon their merits in such a manner as it may deem best from time to time.

Many present-day students of these problems are advocating the development of a national system of unemployment insurance for industrial workers as a means for relief of unemployment distress. The proponents of these plans are somewhat vague as to whether they should deal with the casually unemployed only, or include also provision for relief of depressional unemployment; also as to how these objectives would be accomplished.

While there is much difference of opinion as to the feasibility

of relieving the distress arising from casual unemployment through the medium of unemployment insurance or reserves, there can be no confusion as to the impossibility of relieving by this method the distress arising from depressional unemployment such as we are now experiencing.

The distribution over industry of a burden of the character of unemployment insurance or reserve accumulation is vastly complicated; either it must be distributed as a flat burden upon production volume, or on payroll, in which event those industries with the least unemployment would bear a burden totally out of proportion to the relief required by their unemployed, or it must be distributed in proportion to the unemployment existing within each section of industry, in which case the result would be still more disastrous in that it would burden to the breaking point those industries having the greatest employment fluctuations. By increasing the cost of such goods by such a burden, the demand for them would be further curtailed, thereby intensifying the unemployment to be relieved.

Whatever method of accumulation is used, a further vitally important task remains to be solved, that of investing the resources accumulating during periods of normal or supernormal employment and the liquidation of these investments to procure relief funds during periods of subnormal employment in an effort to achieve the result of storing and transferring purchasing power through time. The very conditions that create supernormal and subnormal employment would make the investment of such funds inflationary and expensive in periods of prosperity and their liquidation disastrously deflationary in periods of depression.

Regardless of what may be done with respect to insuring or reserving against casual unemployment, relief of the distress arising from depressional unemployment will still be necessary. Industry recognizes this necessity.

Neither casual nor depressional unemployment relief should be provided on the basis of right as an obligation of society or of industry to the individual, but rather on the basis of need where and to the extent the need exists. It should be financed by private volunteer funds where possible, but where necessary by local, state, and Federal Government resources, in the sequence noted, through current taxation, to the extent possible, and through expansion of government debt, as required, to be liquidated by future taxation. It should be distributed for useful work where possible but by outright contribution where necessary. Such distribution should be effected through local channels only.

There can be no question but that, as the complexities of our industrial civilization become greater, more and more attention must be given to the protection of the individual from destruction arising from contact with forces that are completely beyond his power to control. Protection of this character should properly be carried on, however, by society as a whole and not as an additional burden upon private business.

RECOVERY AND REEMPLOYMENT WILL COME WITH A REVIVAL OF THE SPIRIT OF ENTERPRISE

Recovery must come by reemployment where unemployment now exists, that is, in the field of durable goods. The renewal of these processes of national rebuilding and development is for the best interest of all, the worker, the consumer, and the investor. Never in the history of our country has there been such a suspension of these processes for so long a period nor has there been so great an accumulation of obsolescence in the facilities of the nation needed for living, for industry, and for commerce.

These processes will be renewed, however, only by a fundamental change in our social order, so that they are thereafter controlled by the state, which change will not occur, or by a revival of the spirit of enterprise and a constructive outlook to the future on the part of business management. This revival will come, in fact, is almost upon us now. All we need is a clearing away of the remaining obstacles, most of which have been created in fact, or in the minds of business men, by enthusiastic theorists in the interest of social advancement, without realizing that society can advance no faster than all its parts, and that reform, no matter how desirable, cannot make permanent progress over a prostrate business structure.

The correction and prevention of economic instability will not be accomplished by highly centralized planning of national scope, but rather by a better and more sympathetic understanding by all of the characteristics of our economic life, the maladjustments to which it is subject, and their cause and correction.

Let us all then give our support to those forces, now making their appearance, which are moving in the direction of this revival. Let us, at the same time, seek to understand the social as well as the industrial problems of our people and to assist in their solution, without compromise, however, of those principles and practises of individualism and sound private enterprise, which have constituted the rugged foundation upon which America has been built and which today holds out the only real hope for her future.

Ewing Galloway, N. Y.

Problems Confronting the DURABLE-GOODS INDUSTRIES

By FRANKLIN R. HOADLEY

VICE-PRESIDENT, FARREL-BIRMINGHAM COMPANY, INC.

ON THE basis of the premise that reemployment and national recovery are dependent upon recovery of the durable-goods industries, let us consider the factors which are influencing recovery. In the first place we must admit that some recent developments are exceedingly hopeful. The National Housing Act is a piece of sound legislation which seeks to stimulate the flow of private capital into private enterprise, and is already resulting in a large increase in the number of inquiries for modernizing which will stimulate the construction industries and help employment.

Recently the Administration has evidenced a more conciliatory attitude toward industry and toward the bankers, who must be partners with industry in the financing of business which in many instances must be transacted on a credit basis.

If the restraints to production in the heavy industries are removed there is every reason to be sure of a rapid improvement in business. There are tremendous frozen assets which will be released when general confidence has been restored. Consider the volume of savings-bank deposits and excess cash reserves of many banks. Huge sums of money are on deposit which are earning practically no interest. Great quantities of money will seek investments which will pay a more adequate return when confidence is restored. It is common knowledge that business recovery is going forward in nearly all the important countries of the world. In the early years of the depression we had poverty in the midst of plenty, because working funds were tied up in the general collapse of the boom period, but now we have huge shortages that need to be made good. We are restrained by artificial barriers from making use of the factors which have always made for prosperity. We have millions of idle workers seeking jobs, and money and credit seeking employment. It has been estimated that there is one hundred billion dollars worth of accumulated work waiting to be done, and we have all the factors with which to do it except profit possibilities, sufficient investment freedom, and monetary confidence.

In spite of some optimistic developments we are still confronted with alarming uncertainties, many of which can and should be removed promptly. Recent executive orders indicate that we are still far from the removal of government interference with private business, and, unless one can subscribe to the tenets of a planned economy, such interference is cause for grave alarm.

There has been little in the developments of the National Industrial Recovery Act that can persuade us that a planned economy would improve our conditions. Unfortunately there is some division in the ranks of industry in its opinion as to the desirability of continuing NRA. Apparently the great majority of manufacturers have failed to obtain benefits under the act at all commensurate with higher costs, and would like to see the act wiped out when it expires next June and replaced by nothing more definite than a child-labor law and possibly a minimum-wage law. On the other hand, there are several industries, some of them very large, which, through open-price provisions in their codes, have benefited greatly, and the representatives of these industries will fight for a continuation of many of the provisions of the recovery act, although probably they will subscribe to modification of the act. The division of opinion within the ranks of industry is most unfortunate because it lays industry in general open to the criticism that it does not know what it wants and is therefore incapable of regulating itself. But it is not surprising that hundreds of different industries cannot agree.

Galloway, N. Y.

"THE ONLY SOUND METHOD FOR BETTERING THE CONDITIONS OF LABOR IS TO ENCOURAGE CONFIDENCE BETWEEN EMPLOYER AND EMPLOYEE"

Regardless of the fate of the recovery act when it expires by limitation next June, there have been certain advantages gained from the experience of the past year and a half which should be capitalized. Under the necessary contacts of code making and code administration, trade associations have been enabled to develop beyond their fondest dreams. Competitors have become acquainted and have learned to benefit by mutual study of their common problems. Well-organized trade organizations should hereafter play a more important rôle in promoting cooperative action within the limits of the law and on the basis of voluntary agreement.

The majority opinion of those who have been connected with code activities seems to have crystallized along the following lines: That

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while published prices or some form of price fixing may be beneficial to an industry, due, however, to the government's concern over the rights of the consumer, any privilege extended to an industry to fix prices must carry with it the obligation of that industry to submit to government supervision. Government supervision carries with it the implication of government control and bureaucracy, and many individuals, who a year and a half ago were hopeful of the benefits to be derived under the recovery act, have decided by this process of reasoning that they would much rather take their chances with free and open competition.

There is still great fear of a planned economy and its results. Can we be assured that many of the measures which were planned to relieve a temporary depression will not be made permanent, and include dangerous experiments which may threaten our whole economic system? Shall planned economy with curtailment of production and a reduced standard of living replace the philosophy of plenty which advanced the country to unknown levels of general prosperity? Our average standard of living is the sum total of all the goods and services produced, divided by the number of people there are to use them. Prosperity and a rising standard of living cannot exist in the face of restriction of production and a diminishing output of goods and services. The less the volume produced, the smaller each person's share and standard of living will be. May we not seek to apply corrective measures to the unbalanced conditions that exist and return to the distribution of all possible goods and services to all of the people, which has been the aim of farsighted men for ages past?

We can be justly fearful of the competition of government with private business because it has been the experience that when government goes into business it stays in business, and thereby reduces private employment and increases government payroll. The Tennessee Valley Authority and many other Federal projects are a natural source of great alarm.

It is natural that the business man feels he must conserve every available dollar to defray increased costs of possible further social experiments. He has been suffering from increased costs of legislation which he was led to believe was temporary, but is far from sure that it will not be permanent. He has seen the relief rolls increase from 15,000,000 in August, 1933, to 18,000,000 in August, 1934, and he is led to expect a more radical and money-spending Congress in its next session. He looks forward to heavy future taxes to pay a bulging deficit and has no assurance as to when the budget will be balanced. In addition there is the greatest uncertainty concerning the monetary situation, and he has no assurance that his surplus will not be taxed so heavily as to cripple his business.

COLLECTIVE BARGAINING BY STATUTE

If we consider the labor situation in its broadest sense, we find a strange and illogical condition which should be proof positive that activities in behalf of labor have been directed along unsound lines. Undoubtedly, organized labor has made some progress in adding to its membership under the encouragement of Section 7-A of the National Industrial Recovery Act and we must recognize that some employees have gained advantages which are rightfully theirs. But let us consider the picture as a whole.

It is a strange paradox that at the end of a year and a half of the most paternalistic treatment ever accorded labor by a national administration there exists unemployment of nearly 11,000,000, a loss of confidence between employers and employees who, in many instances, have dealt with one another harmoniously for years, and even dissatisfaction on the part of organized labor because it has not made all of the progress it expected to make under the encouragement of the government.

There is no doubt that to an absurd degree it has been assumed that sweat-shop methods were characteristic of employers in general, and consequently Section 7-A is punitive because it puts full legal responsibility upon the employer and requires little or no responsibility from the employee, or, more particularly, the labor union.

Contact with a great many employers, through code activities and mutual interest in heavy-industry problems has brought conviction that most employers realize that their success is contingent upon the well-being of their employees. One seldom meets an employer who does not deplore the practises of the sweat-shop operator or any other exploiter of labor. Yet the punitive Section 7-A and especially its interpretations tend to place all employers in the same category. I maintain that the only sound method for bettering the conditions of labor and employees in general is to encourage in every possible way the confidence between employer and employee. Great strides have been made in this direction in the past twenty-five years, but the present vindictive and persecuting attitude has seriously retarded this progress. Employees are encouraged to disagreement and friction.

Collective bargaining is intended to lead to an agreement or contract between the parties who are bargaining. Should compulsion from either side enter into a contract? Can fair wages be determined by the relative bargaining power of employer and employee? Are not legitimate wages the result of natural laws, over which each side has very limited control? The general price level of commodities is affected very little by bargaining and there is likewise a general fair rate for every kind of labor. Let us by cooperative and voluntary action undertake to pay those fair rates in each industry which are consistent with economic conditions within the industry.

In the long run the leaders of industry will have a voice, and by leaders, I refer to every employer in the land. Let every employer insist that labor be held equally responsible for its activities. Every honest and conscientious employer should be recognized as such and be given the latitude and freedom from interference which he merits. Every exploiter of labor should be prosecuted and given his just deserts. Bad leadership of both management and labor should be rooted out. No good can come to industry or its partner, labor, from the selfish activities of politicians, radicals, demagogues, and ignorant social reformers.

Much could be gained by legislation similar to that in England prohibiting general strikes, sympathetic strikes, and efforts by one group of workers to keep other persons from working. These are activities now countenanced in this country which lead to riots, bloodshed, and violation of the rights of citizens.

WAGE INCOMES AND PRODUCTIVITY

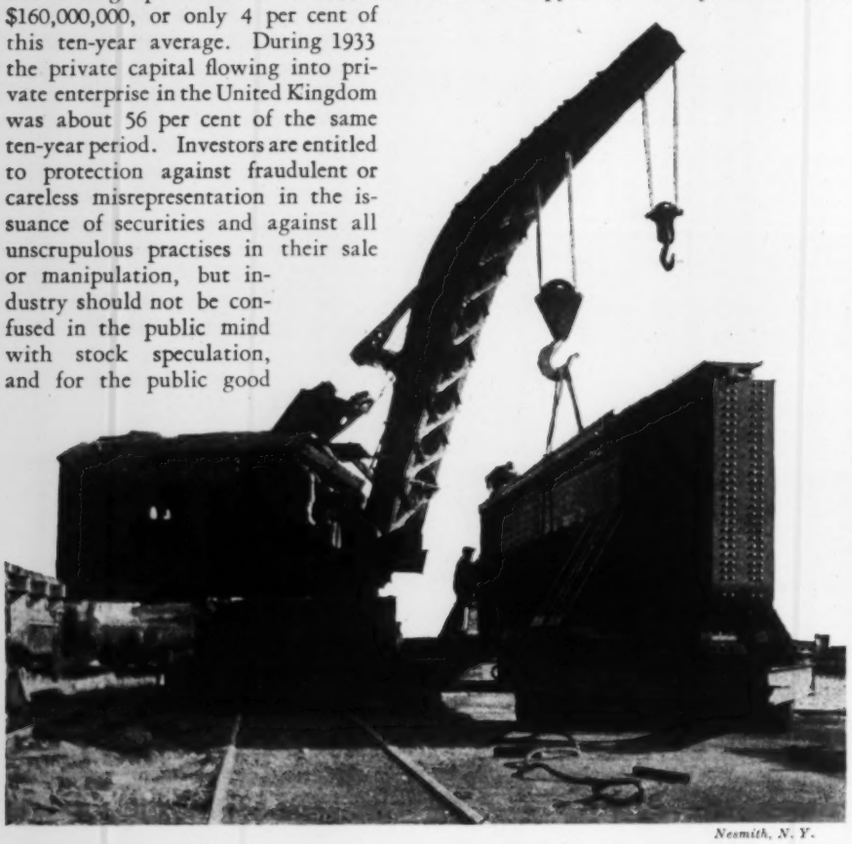
Reduction in maximum hours has already been carried to, or probably beyond, the economic limit in the heavy industries under present conditions, and further reduction is more apt to reduce employment than to increase it, because of increased costs and prices which, in spite of any ideas to the contrary, are bound to reduce the volume of sales. Prices are not a measure of prosperity, since price is merely a rate of exchange of goods and services, whereas wealth is dependent upon the volume of goods exchanged. In turn, the volume of trade depends upon balanced prices which will promote the exchange of equal values. Technological improvement may eventually enable the worker to produce in 30 or 36 hours the output now requiring longer hours, but further shortening of hours at present would be artificial. By the same token, high wage rates do not increase purchasing power, since wage rates alone cannot regulate

the dollar income of workers, which is principally governed by total hours worked per annum and the productive values created during those hours. Manufacturers require flexibility regarding wage rates in order to obtain a volume of sales which will require the largest number of productive hours and the consequent maximum dollar income for the worker. For example, in 1931 the workers in the paper industry produced an average value each of $3439 and received an average wage per annum of $1184. In contrast, the clay-products industry with lesser productivity had an output per worker of $1758, with an annual wage per worker of only $877. Low productivity can only mean low annual income for the worker and a reduced standard of living.

Industry has been accused of selfishness and many other crimes for which it is not responsible. Industry's insistence upon increased productivity as a basis for recovery is actually a constructive program of the greatest possible advantage to all.

FINANCIAL BARRIERS TO RECOVERY

One of the most serious restraints upon the recovery of normal business is the restriction of the flow of private capital. Let us bear in mind that all durable goods on the average must be completely replaced every twenty-five years, which tends to confirm the tremendous demand which will be released when the present restrictions are removed. However, a large part of this possible production must be financed by a continued input of new capital by a distribution of the savings which have been created. In the ten years ended with 1930, American business was supplied with new capital, through the sale of securities other than refundings, to the amount of about four billion dollars average per annum. In 1933 this volume dropped to $160,000,000, or only 4 per cent of this ten-year average. During 1933 the private capital flowing into private enterprise in the United Kingdom was about 56 per cent of the same ten-year period. Investors are entitled to protection against fraudulent or careless misrepresentation in the issuance of securities and against all unscrupulous practises in their sale or manipulation, but industry should not be confused in the public mind with stock speculation, and for the public good must have its normal supply of new capital. There is no possibility of bringing about economic recovery if difficulties in issuance of, and subsequent trading in, securities go to such lengths as to discourage private initiative. The Securities Act of 1933 was amended by the last Congress, but requires further amendment. The Securities Exchange Act of 1934 also requires amendment. The Stock Exchange Commission has conscientiously endeavored to be helpful within the scope of the regulations which control it, but these pieces of legislation contain restrictions of a punitive nature which discourage private initiative and cause reputable men to shrink from the possible defense of unjustified nuisance lawsuits and, moreover, from imperiling their future well-being by incurring undefined liabilities.



Nesmith, N. Y.

"REEMPLOYMENT AND NATIONAL RECOVERY ARE DEPENDENT UPON THE RECOVERY OF THE DURABLE-GOODS INDUSTRIES"

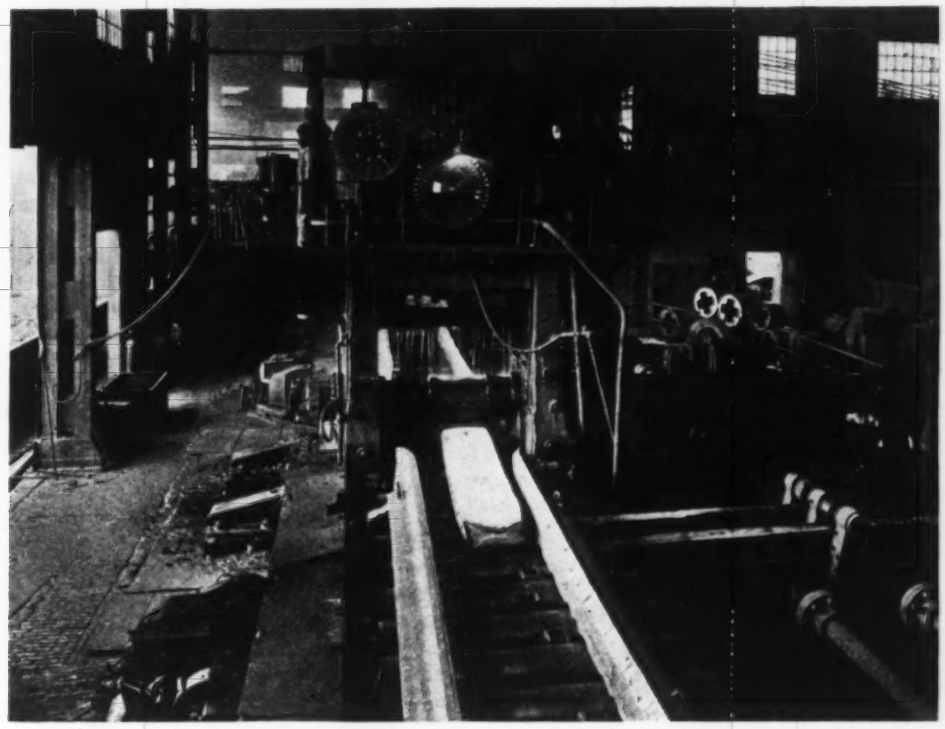
REQUISITES OF RECOVERY

The Durable Goods Industries Committee's report to the President stated, in part, as follows: "Today's challenge to America is: Labor must be given an opportunity to work and be self-supporting, not at the expense of any other group, but through the creation of those things necessary to sustain life and improve the standard of living of every part of the country.

"Recovery in the broadest sense is the reestablishment of private agencies instead of public relief by governmental agencies as the means of livelihood of the people."

We have a common desire of millions of people to bring about recovery, and, through an informed and aroused public opinion, let us insist upon those constructive policies which will assure prosperity; repeated assurance to private enterprise that the profit incentive will continue to receive public approval as an energizing motive for economic activity; public recognition that the only legitimate purpose of taxation is to provide the necessary revenue for government and not to effect an idealistic redistribution of wealth which paralyzes business initiative and, by its implications, threatens a breakdown of our entire economic system, which can only be replaced by other systems which have never proved successful.

Let us have the earliest possible reassurance of a balanced budget, an early removal of the threat of uncontrolled inflation or of any sudden and arbitrary change in our monetary policies. With the natural eagerness to punish the offender, let us be careful that reform measures be limited to destruction of the bad, and not the good, and that such measures shall extend no favor to any special group, but that all groups shall be responsible for those obligations which are a counterpart of their privileges. We require a general clarification of the government's policies toward measures and trends which are inconsistent with our economic system. With these assurances we shall have necessary relief and adequate reforms, but what is vastly more important, by the release of natural forces, we shall have reemployment and national recovery.



A TWO-HIGH REVERSING BLOOMING MILL

STEEL-PLANT LUBRICATION

By J. F. PELLY

BETHLEHEM STEEL CORPORATION

ONE of the problems that is rapidly coming into the prominence it deserves in modern industry is that commonly known as lubrication. The term itself unfortunately fails to convey to the average person any idea of the economic advantages to be obtained in this particular field. The insignificant cost of lubricating oils compared with other manufacturing costs also tends to minify the problem of lubrication. When, however, a studyi s made of the maintenance costs on bearings and gears in a steel plant and when it is considered, for instance, that, roughly, one-half of the power required for rolling steel may be used to overcome the friction of the roll necks, lubrication resolves itself into a major item of operation.

The science of lubrication is sufficiently developed now to make possible large reductions in friction losses on existing equipment. The designers of the future must know and apply the fundamental principles of lubrication to all contacting parts having relative motion. Every effort must be made to supersede the intermittent lubrication of the past by flood lubrication governed by automatic devices, regardless of whether the lubricant is oil or grease. It will be necessary to design all parts of the equipment so that leakage will be a minimum, particularly when oil is the lubricant. The question of the type of bearing will be an important one, always, however, from the standpoint of lubrication. For instance, there are many places where ball and roller bearings may be introduced with marked saving in maintenance costs such as on high-speed, light-duty equipment in a dusty or dirty atmosphere; in other places a plain bearing, well lubricated, will give almost unlimited service.

Lubrication is also a big factor in two other phases of modern steel practise: First, mills are being designed with higher and higher speeds. Interruptions to the production schedule cannot be tolerated. Automatic scientific lubrication is the only answer. Second, there is an increasing demand for close tolerances in rolled products amounting almost to a machine finish. The usual intermittently lubricated roll-neck bearings are a constant menace in this respect, and at times cause heavy rejections of material. Roller bearings, specially designed plain bearings, lignum-vitae bearings, and bakelite-composition bearings have been introduced in the endeavor to overcome this difficulty.

In a large steel plant the lubrication problems vary to extremes at different parts of the operation, not only in the matter of temperatures encountered, but in the quality of lubricant needed and also in the difficulty of operation.

Contributed by the Iron and Steel Division and the Lubrication Engineering Committee and presented at the Annual Meeting, New York, N. Y., December 3 to 7, 1934, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

It is quite a different problem to lubricate an engine placed alongside the mill it is driving with all the attendant accumulation of dust, as compared with an engine located in a clean, isolated building. The only remedy, with the exposed engine, is to cover every working part and install a circulating-oil system with efficient filters.

The problem of lubrication is moreover becoming more and more involved from the standpoint of the lubricants alone. A large number of oil companies are offering a rapidly increasing list of products. The perplexed purchaser is further confused by the fact that each oil company has its own number, letter, or name, for products more or less similar. If the purchaser desires to give several oil companies a portion of his business, various operating departments will from time to time be obliged to replace satisfactory lubricants with others of doubtful value. Just as many people feel sure that only one or two motor oils give satisfaction in their automobile, so it is the case in the various departments of a large steel plant, and when the equipment is vital to the operation of the plant it is evident that difficulties may arise in making changes of lubricant.

The plant lubrication engineer must master the complexity of this situation and satisfy himself by constant laboratory and practical tests that the products coming into the plant are satisfactory and uniform. It is also his task to hold the number of types of lubricant to a minimum.

In Table 1 are listed oils used in a certain steel plant consisting of raw-material-handling equipment, coke ovens, blast furnaces, open hearths, and various mills, including wire, pipe, sheet, and tin mills:

TABLE 1 LUBRICATING OILS USED IN A STEEL PLANT

Name of oil	A.P.I. gravity, 60 F	Viscosity, Say-bolt sec— 100 F	210 F	Application
Turbine oil	29	150	.....	Steam-turbine circulating system
Turbine oil	24/28	275	.....	Turbo-blowers, geared turbines, motor-generator sets, air compressors, gas-booster turbines
Red engine oil	25	285	.....	18-in. mill pinion circulating system, all motor bearings ring-oiled up to 6000 hp, general lubrication, gas-engine circulating system
Heavy turbine oil	26	550	.....	Skelp and rod-mill gear circulating systems, plate and rail-mill drive gear circulating systems, small spur-gear reductions
Engine oil	23	680	.....	Locomotive journals—summer only
Black oil	15/21	...	70/90	Mill tables waste-packed or ring-oiled, mill-table closed gear cases, soaking-pit cover mechanisms, shear tables—runout and approach
Heavy turbine oil	26	1700	.....	21-in. mill pinions and reduction gears and bearings (cut with heavy turbine oil to 900 sec viscosity)
Steam-refined cylinder oil	26/27	...	145/155	Blast-furnace-gas-engine cylinders
7 per cent compound cylinder oil	23/25	...	132/140	Steam cylinders—saturated steam Worm-gear reduction sets
15 per cent compound cylinder oil	24/26	...	125/130	Locomotive cylinders

Engine oil represents about one-half and black oil one-third of the total quantity involved in this list.

COMMENTS ON STEEL-PLANT OILS

Turbine oil of 150 sec viscosity[1] is used in various plants on steam-turbine circulating systems.

Turbine oil of 275 sec viscosity is used on turbo-blowers and geared turbines. This oil is also used in air cylinders. Another plant has used a good grade of 150 sec viscosity engine oil for years on air cylinders with good results. Others use a 400-sec viscosity turbine oil. A minimum feed is almost as important as the quality of oil.

Engine oil of 285 sec viscosity is the general-purpose oil. For many years a 200-sec viscosity oil was used except on large ring-oiled motors. Other plants use a 250-sec or 300-sec viscosity engine oil, some of paraffin and others of asphaltic base. The asphaltic-base oils have proved satisfactory except on gas-engine and rod-mill-engine circulating systems, probably because of the higher temperatures involved. Another plant uses a 150-sec viscosity engine oil as a general-purpose oil.

Two heavy turbine oils are indicated, one of 550 sec and one of 1700 sec viscosity. These oils are used on gears and pinions. It is very convenient to have two oils such as these as they can be blended at the various mill systems to give any desired viscosity. The heaviest combined viscosity is 900 sec or 1000 sec.

Engine oil of 680 sec viscosity is used on locomotive journals in summer. Some plants use black oil or a similar product of about the same body. In winter, car oil, red engine oil, or winter black oil of about 300 sec viscosity at 100 F is used.

Black oil of 70/90 sec viscosity at 210 F, summer and winter grade, is a low-priced lubricant for general-purpose use throughout the plant where a certain amount of waste through leakage, owing to design or as a result of crude application, is unavoidable It is also used on car journals in summer and is replaced by engine oil in winter The car journals in one plant are lubricated with 300-sec viscosity engine or car oil, and no black oil is used. Another plant uses winter black of 330 sec viscosity at 100 F both summer and winter on car journals.

Steam-refined cylinder oil of 150 sec viscosity at 210 F is also used for large blast-furnace-gas-engine cylinders. Experimental oils as low in viscosity as 80 sec at 210 F have been tried, some compounded and some not, and some highly refined. It has been found that the most economical oil is a straight oil containing an average amount of carbon residue. This residue seems to hold the oil on the hot cylinders and rods, thus giving better results than a filtered oil.

Steam-cylinder oils of 7 and 15 per cent compounding are rather unusual. In most plants 5 or 6 per cent is used, but both types give satisfaction. A viscosity of 140 sec at 210 F will take care of practically all mill engines and locomotives. One plant uses a viscosity of 170 sec at 210 F and 8 per cent compound.

COMMENTS ON STEEL-PLANT GREASES

An attempt has been made, Table 2, to describe the grease requirements of a steel plant. The viscosities and densities indicated are rough approximations but serve the purpose of establishing a fair picture of the type of product in each case. The densities are referred to cup-grease densities by comparing penetration figures. This is, of course, hardly permissible, but is accurate enough for the purpose desired here. It would help every one if greases were bought on A.S.T.M. penetration figures.

Cup grease is in common use for hand cups in all plants. We are trying to develop cup greases having heavier oils as they are used mostly on heavy machinery, slow moving, and with large clearances in the bearings.

[1] All viscosities are at 100 F unless otherwise noted.

TABLE 2 GREASES USED IN A STEEL PLANT

Kind of Grease	Base	Approximate viscosity of oil, Saybolt sec	Approximate density	Application
Cup grease	Lime	100/150[a]	3-4	Hand grease cups, pressure grease fittings
Pressure grease	Lime	800[a]	0-1	Ball and roller bearings, plain bearings, hand or power pump greasing systems
Hot-bed grease	Lime	250	1	Hot-bed skids
High-temperature roller-bearing grease	Soda	70[b]	1/2	Roller bearings on ingot cars and ladle cars, roller bearings subject to heat
Wool-yarn grease	Lime	300[a]	1	Crane journals
Graphite grease	Lime	1200[a]	2 1/2	Mill housings and bearings
Plunger grease	Lime-graphite	....	1	Hydraulic plungers
Hot metal car grease	Soda	150[b]	Solid	Plain bearings subject to heat, hot-metal ladle cars
Gear coating	Asphalt	500[b]	0	Reduction gears
		2000[b]	2	Gear drives
		5000[b]	5	Open gears
Roll-neck grease (two or more densities)	Lime-tallow-graphite	....	Solid	Roll necks
Roll-neck pressure grease	Lime-cylinder oil	....	2 1/2	Power-pump greasing systems
Hot-neck and mixing grease	Asphalt and cylinder oil	....	Solid	Tin and sheet-mill bearings

Hot-neck and mixing grease represents 57 per cent of the total quantity of grease involved. Cup and gear coating each represent 10 per cent, and cold roll-neck grease 13 per cent.

[a] At 100 F. [b] At 210 F.

The viscosity of the oil used in a pressure grease should be noted.

In order to obtain the proper body or density it has been considered better to have heavy oil and less soap content. Some plants use 300-sec viscosity oils in pressure grease. For outdoor use on long lines in winter, a low cold-test 300-sec viscosity oil is needed in the grease.

Hot-bed grease is used on certain types of skids which need real lubrication. Usually all that is needed is black oil or even tar.

Roller-bearing grease capable of resisting the temperature conditions existing on ingot and ladle cars is in general use.

Wool-yarn grease is widely used in crane journals. Sometimes a light grease is used for replenishing the lubrication in the yarn. Often cylinder oil or engine oil is added for the same purpose.

Graphite grease is used as a general-purpose grease about the mill.

Plunger grease is used in small quantities. Generally, cylinder oil, black oil, and graphite are made up and applied in each plant in various ways, depending on conditions.

Hot-metal car grease is used on waste-packed plain bearings, on hot-metal ladle cars, and on cinder cars which are subjected to heat.

Gear coatings are usually of asphaltic origin, made in various densities to suit conditions. Sometimes cylinder-oil compounds are used, or lead-base compounds, or even ordinary grease. The tendency today is toward medium-bodied mineral oils for circulating systems.

Roll-neck grease is the solid grease packed on roll necks. The tendency is toward roll-neck-pressure grease in the larger mills.

Hot-neck and mixing greases are asphalt derivations containing heavy lubricating oil having a high flash point. The bearings they must lubricate have temperatures of about 350 F or even higher. The grease is either laid on in chunks or melted and swabbed on. Power loss is undoubtedly high with this lubricant. Recently, attempts have been made to apply pressure systems to these necks.

LUBRICANTS FOR ROLL-NECK BEARINGS

In the steel plant in which the practise noted in this paper is based 70 per cent of the grease was required for cold- and hot-neck bearings. In a large steel plant without sheet and tin mills the cold-neck bearings would require from 35 to 45 per cent of all the grease used. The lubrication and design of the roll-neck bearing is therefore of vital interest.

Considering the cold-neck bearing, which is the predominating type, it is customary to pack the neck with a fairly hard grease consisting of tallow and mineral oil and sometimes graphite. A stream of water running on the neck helps to hold the temperature down.

Formerly, bronze bearings were used, the usual reason given being that the pressures were too high for babbitt. Later, babbitt bearings were used with bronze inserts and bronze thrust collars.

Several years ago it was decided to make a study of the babbitt and bronze situation in a certain steel plant and it was found that the practise of using babbitt over and over again with the unavoidable contamination from the bronze strips was not satisfactory.

To eliminate the bronze thrust was found to be impossible. Nevertheless, remarkable success was obtained by planing the strips down and babbitting over them. The bearing proper was then of babbitt only, an 80 per cent lead, 15 per cent antimony, 5 per cent tin babbitt. In addition to increased bearing life, there was an undoubted saving in power and a considerable saving in bronze. A remarkable saving in babbitt was obtained as the plant used only one-third as much babbitt per ton after the bearings on all mills, including blooming mills, had been changed. A few maximum-tonnage comparisons, given in Table 3, may be of interest as showing the increased life of bearings.

TABLE 3 MAXIMUM-TONNAGE COMPARISONS

Size of blooming mill, in.	Location of bearing	Maximum life of plain babbitt bearing, tons	Maximum life of former babbitt and strip bearing, tons
40	Intermediate	127747	85228
40	Top	120456	64394
40	Top	106436	33201
40	Bottom	84871	42818
46	Bottom	169025	120163

Average tonnage is not always the correct way for comparing bearings. It may represent only the variation in care bestowed on the bearings at different periods. An epidemic of burned-out bearings will ruin the most carefully laid plans for comparison. There are enough data on hand, however, to indicate that twice as much tonnage is being averaged from these

bearings, which means that some are producing three or four times the original average tonnage.

The study that resulted in these improvements brought out very clearly the fact that the important requirement for further development was constant lubrication. The human element cannot be depended on for this, nor can it even be expected to maintain this condition. In practise, the grease melted away from the neck, and unless some one happened to tamp the grease every hour or so, there were long periods when water was the main lubricant.

In order to determine whether there was an appreciable difference if the grease were held on the neck, tests were made using grease pans lying on the bottom neck of a number of merchant mills. Table 4 records the results of a grease economy test. It has been noted that bearing life increases with a reduction in the amount of grease used.

TABLE 4 GREASE ECONOMY TEST

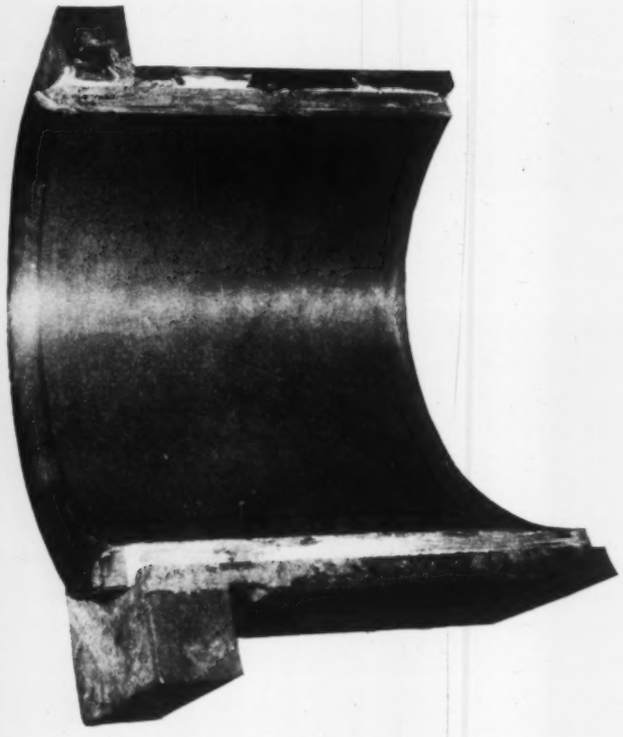
Mill, in.	Tons per lb of grease, without pans	Tons per lb of grease, with pans
14	11	33
13	30	35
12	6	10
10	14	22
9	7	12
9	7	15
9	4	7
8	7	9

The pans not only saved grease owing to the constant feed resulting from the weight of the pan but they also deflected scale from the bearing. Moreover, with frequent roll changes in small mills, the grease is lifted off with the pans instead of being thrown away.

This showed the real need for the controlled automatic lubrication of roll necks. Devices for such lubrication were on the market, but the general opinion was that heavy-duty roll necks needed hard heavy-duty grease. This meant very expensive equipment for pumping the lubricant to the bearings at high pressure.

Experiments were therefore started in 1929 with a soft tallow-graphite cylinder-oil, roll-neck pressure grease in an improvised pumping apparatus. The equipment operated for nearly a year on a bearing subject to extreme pressure and generally severe service. In the meantime other tests were conducted on heavy-duty necks applying the soft grease at regular intervals through manually operated grease cups. The results were so conclusive that as soon as automatic centralized systems, adapted to roll-neck lubrication, were commercially available, various types were installed on a number of mills.

Sufficient data have been accumulated to date to show that the bearing life is increased from 40 to 150 per cent and the consumption of grease reduced about 35 per cent. Many tests have been run for the purpose of determining how much the power saving might be. It is axiomatic that longer bearing life indicates less friction and therefore less power consumption. The results showed from 1.5 to 30 per cent saving in power for a number of types of mills. An average power saving of 10 per cent is in our opinion a fair estimate, and this item alone will easily justify the installation of grease systems on many mills.



A BLOOMING-MILL ROLL BEARING WITH BRONZE THRUST COLLAR AND NO SIGN OF BRONZE STRIPS

BAKELITE-COMPOSITION BEARINGS

As already shown, the automatic grease system applied to roll necks made a notable improvement in steel-plant lubrication. The advent of lignum-vitae and bakelite-composition bearings, however, has changed the situation to a certain extent. Where successful, these bearings show such an increased life over the ordinary plain roll-neck bearing and so great a saving in power that in our opinion no major grease lubricating system should be installed until it has been definitely proved that the new bearings will not operate on the mill under consideration. Successful use of these bearings depends more on the way they are handled in the mill than on the physical conditions under which they operate. Some are working under pressures of 4500 lb per sq in. and one set under a calculated pressure of 6500 lb per sq in.

TABLE 5 POWER TESTS

Type of Bearing	Bar size, in.	Percentage of reduction	Rpm	Hp input	Friction load, hp
Lignum vitae	$7^{11}/_{16} \times 0.225$	20	215	362	41.8
Babbitt	$7^{11}/_{16} \times 0.225$	20	215	467	73.0
Bakelite	$7^{11}/_{16} \times 0.18$	13.9	258	285	28.0
Babbitt	$7^{11}/_{16} \times 0.18$	13.9	258	628	131.0
Bakelite	$7^{11}/_{16} \times 0.18$	13.9	366	228	50.0
Babbitt	$7^{11}/_{16} \times 0.18$	13.9	365	965	104.0

The life of nearly all roll-neck bearings, including wood and bakelite is determined by the rate of wear on the thrust collar. On bakelite bearings having separate thrust collars, the thrust collars are sometimes renewed from three to six times during the life of the bearing proper. Side thrust has been particularly troublesome in the case of bearings made wood and composition materials.

Bakelite composition compresses considerably more than bronze under a given pressure. In the mill, the operator will naturally try to tighten up laterally with the same vigor he is accustomed to use against bronze collars. This results in quick cutting away of the collar. Regardless of these difficulties it is believed that wood and bakelite-com-

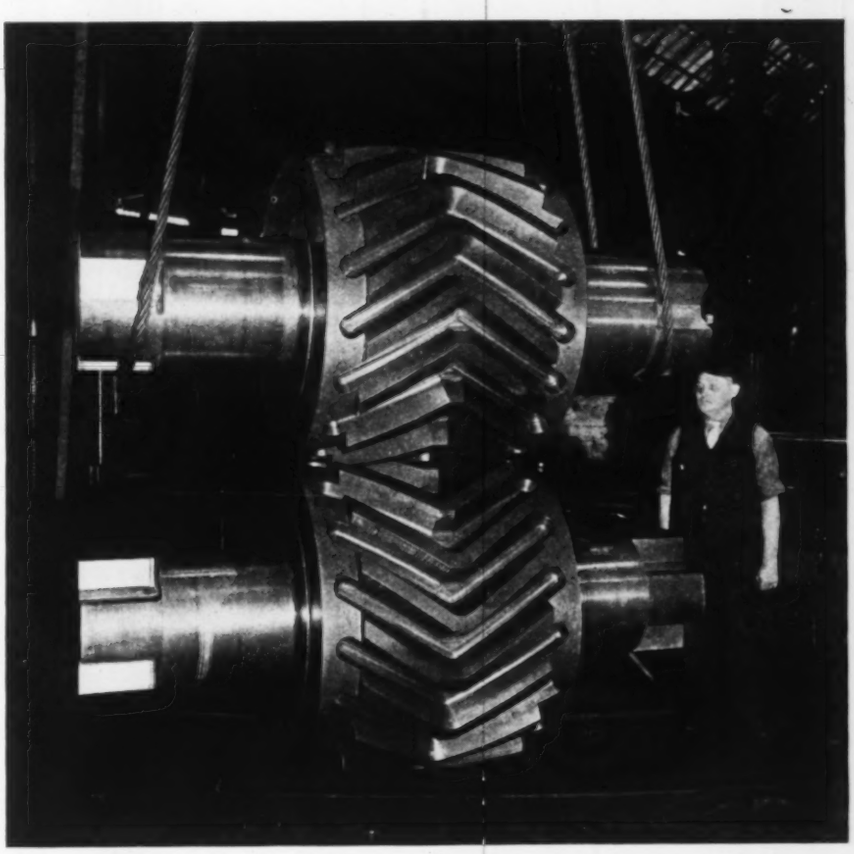
position bearings will gradually be extended in their use so as to include nearly all steel-mill roll necks except those having speeds under 100 ft per min, or those cooled with salt water.

Some interesting power tests have been run on a 12-in. skelp mill. A few of the comparative results are given in Table 5.

Here are power savings of 50 to 75 per cent in favor of bakelite-composition bearings, in comparison with plain bearings hand packed with grease.

On a rod-mill, lignum-vitae bearings show a 30 per cent power saving compared with plain bearings, hand packed with grease.

If it is possible to save 300, 400, or 600 hp on a single stand of a medium-sized rolling mill simply by introducing wood or bakelite bearings, it is important that every effort be made to introduce this type of bearing in the various steel plants. It should be stated, however, that equally great savings in power are said to be obtained from special plain bearings running on oil-circulating systems.



A SET OF BLOOMING-MILL PINIONS

MILL PINIONS AND GEARS

Until a few years ago it was customary to lubricate mill pinions with a heavy-bodied pitch, swabbed on, if in an open housing, or by bath application, if closed. It was considered necessary to have a heavy-bodied lubricant in order to absorb the shock.

With higher carbon, herringbone, spiral-cut teeth, and with higher speeds, lubricating oils of lighter body came under consideration. The advantage in using oil was that, by installing a circulating system, both pinions and pinion bearings could be lubricated with one lubricant. Contamination of pinion lubricant with bearing lubricant and vice versa was always a menace to continuous operation and to bearing life. Various ingenious devices have been used to avoid this difficulty. For example, many steel-mill pinions are lubricated with pitch of various consistencies, whereas the bearings are fed with heavy oil from an automatic lubricator. There are also special cylinder-oil greases on the market which are quite satisfactory for both neck and teeth.

The advantages of eliminating as much as possible the human element in the lubrication of steel-mill pinions and gears were quite evident to those in close touch with the various causes of shutdowns, but slow progress was made until recently, owing to the lack of data on the ability of medium-bodied oils to withstand heavy concentrated pressure and shock loads.

A certain amount of information was available in one steel plant, however, where a set of 35-in. bloomer pinions had been running for years in a bath of 250 sec viscosity engine oil on a circulating-oil system. The teeth showed wear but not undue wear. Since the first investigation of these pinions, oil has been applied directly to the top pinion and the oil is considered perfectly satisfactory for the purpose.

During the last six or seven years circulating-oil systems have been installed in a number of new steel mills. This has provided a splendid opportunity to study both economy of lubricant and life of pinions and bearings. The results have been better than were anticipated. Occasionally, a pair of gears, when new, will contact on only a small fraction of the tooth face. This will cause flaking until the bearing width has increased. If the bearings are not properly lined up, undue wear appears on one side of the pinions. On the other hand where the gears have meshed properly the tool marks on the teeth have sometimes shown for several years, indicating low rate of wear. The data given in Table 6 should be interesting in this connection.

TABLE 6

Mill	Pressure per in. of face, lb	Speed, fpm	Viscosity of oil, sec at 100 F
10-in. mill, pinions, 4 stands 12 in.	3685 to 831	137 to 484	500 to 550
14-in. structural, 5 stands 18 in.	3023 to 479	141 to 591	500 to 550
14-in. structural, 5 stands 14 in.	1401 to 195	660 to 1100	500 to 550
18-in. mill, 1 stand	7950	121	200
26-in. rail mill, pinions	3980	494	800
26-in. rail mill, reduction gears	1410	2960	800
27-in. continuous, 27 in. pinions	8250 to 8650	46.5	1000 (orig. 1700)
27-in. continuous, 21 in. pinions	2330 to 1290	455 to 780	1000 (orig. 1700)

The wear on each of the pinions and gears on the 27-in. mill was measured after $3\frac{1}{2}$ years of service and it varied from 0.005 to 0.025 in. More than 1,000,000 tons were rolled during this period and the wear is what would be considered normal.

Most of this occurs during the first wearing-in period and has no relationship to the type or body of lubricant used.

These are only a few of the available figures, but they cover a broad field of speed and pressure conditions under which oil is lubricating pinions and gears. In the case of the rail-mill pinions, they ran in a pitch bath for some years until they were ready to be scrapped. The worn-out pinions were allowed to remain in the housing while a circulating-oil system (800 sec viscosity oil) was installed in what was considered more or less of an experiment. The worn pinions were not scrapped until about four years later.

On the other hand, the pinions and bearings of a rail mill at another plant have been running for twelve years on an asphalt stock. The bearings have never been touched and the teeth are worn very slightly.

On an 8-in. mill, where a light asphalt stock is used as a bath, and the bearings are splash lubricated from the bath only, two sets of pinions have been scrapped in eleven years.

It appears that the main consideration is not the type of lubricant so much as proper devices to guarantee that the lubricant reaches the part of the equipment to be lubricated.

As to the body or viscosity of oil required for the lubrication of gears and pinions, it will be noted that gears for the heaviest duty are being lubricated with a 1000-sec viscosity oil. Carefully recorded data show normal wear.

The heavy shocks that steel-mill gears and pinions must absorb are indicated by making a study of reasons for scrapping over a period of years in a large number of mills. Broken teeth, broken wabblers, worn wabblers, and, in a very few cases, worn teeth are the reasons given. It is of special interest, therefore, to note that, in spite of heavy-shock loads, the wear on gears appears to be the same whether heavy-stock lubricants or light oils are used.

LUBRICATION OF LARGE POWER UNITS

Steam turbines and turbo-blowers are usually provided with a small oil reservoir in the base and a force-feed circulating system. We have found it good practise to increase the amount of oil in the system in various ways. The oil is not worked so hard, and has a chance to cool and to settle. If the oil is filtered or centrifuged every three or four months, it will never be necessary to discard it.

Steam-driven mill engines and gas engines should always have a circulating-oil system and filters or centrifuges. If moving parts are enclosed as much as possible and the oil is kept clean, remarkable reductions in maintenance will be obtained.

Mill motors and motor-generator sets are usually ring-oiled and will run satisfactorily of course. A simple gravity-circulating system is, however, a cheap form of insurance against possible shutdown.

Mill-motor drives with reduction-gear cases in one unit are a source of considerable trouble if oil is used on the bearings and pitch on the gears. These units should be designed so as to be oil-tight and arranged for a force-feed oil system on bearings and gears.

LUBRICANTS IN GENERAL

The question is often raised as to the relative value of oil vs. grease, or oil vs. pitch derivatives. In actual practise there is no competition between these products. For lubricating pinions and gears some prefer pitch or special gear greases or specially compounded cylinder oils, in which case some contrivance must be arranged for lubricating the bearings. Excellent results are often obtained in this way. The exponent of one oil for gears and bearings can show equal results in maintenance and economy of lubricant.

Approach and run-out table gears and bearings have been built for circulating oil and for individual grease lubrication. Both seem satisfactory, although it is very difficult to retain oil in some cases, depending on the design.

In most cases where grease is used it will be found that nothing else could be used with economy because of leakage. Moreover, the sealing quality of grease on thousands of small bearings makes it indispensable in steel plants, as otherwise an increasing accumulation of dust would quickly ruin the bearing elements.

On the other hand, for example, is a jaw crusher, which is usually designed for grease lubrication, owing to the shock loads to which it is subjected. Several years ago it was decided to install an oil system on the next one purchased. The results have been far better than expected. Where the bill with grease had been $1 per day it dropped with oil to $0.01 per day and the cleaning effect of the oil brought maintenance down to almost nothing. Here again the effect of shock was entirely missing.

The problem of lubrication consists in the proper application of clean cool oil, or the regular application of a grease that will stay in a bearing without separation. In all cases the lightest oil and the lightest consistency of grease that can be used is the best. The light oil can be more readily cleaned and the soft grease has a higher percentage of lubricant.

THE LUBRICATION ENGINEER

The saving possible in a large steel plant as a result of proper lubrication may run into hundreds of thousands of dollars per year, considering it from the broad standpoint of lubricants, bearings, power, packing, minimized rejection of material, and less loss of time due to shutdowns.

Some of the large oil-refining companies and some of the small compounding or blending companies have lubrication engineers available for service in recommending their products for various purposes and also to act in an advisory capacity to those using their products.

In a large steel plant the problem goes far beyond that of merely knowing the correct lubricant. It requires some one fully acquainted with personnel and equipment and manufacturing practise. It requires constant effort in favor of economy and improvements. It requires a detailed study of expenditures in each department and the compilation and distribution of a chart showing the amounts spent for lubricants each month. The desirability of new oil houses or storage tanks is to be considered. The plant lubrication engineer must consider the possibilities for saving in all appliances pertaining to lubrication, and this alone requires considerable time for interviews with salesmen and for correspondence. In case of hot bearings or shutdowns, he must be ready for call at all times. He must make a study of bearing metals and packing, from both of which trouble may arise. In fact, it was formerly the custom to blame the lubricant for many of the troubles that arose in the mill. The lubrication engineer should be able to determine whether or not this is true, or whether blast-furnace gas or boiler feedwater, or just ordinary dust may be the source of the trouble. Thus in time the lubrication engineer becomes an important member of the organization.

In this outline of steel-plant lubrication it has been my endeavor to picture the advantages of automatic lubrication, of clean lubricants even when obtained at some little expenditure, and finally the necessity for having some one in the organization follow up the work. The number of problems for the lubricating man increases with the amount of equipment in the plant, and the possible savings that he can effect can be large.

The "MORRO CASTLE" DISASTER

Lessons and Observations on the Recent Fire at Sea

By H. L. SEWARD

YALE UNIVERSITY, NEW HAVEN, CONN.

FROM EVERY major marine disaster an important lesson has been learned, but never have there been such obvious lessons as appear to one studying the testimony given in connection with the *Morro Castle*. The *Titanic* taught us lessons in watertight subdivision and the dangers of longitudinal bulkheads. The *Vestris* pointed the way to control of metacentric heights and loading. The *Morro Castle* disaster adds emphasis to the known hazards of fire due to the presence of so much kindling wood, inflammable finish, and decorations.

FIRE-RESISTING CONSTRUCTION NEEDED IN SHIPS

The *L'Antique*, the *Phillipor*, the *Volturno*, and other ships burned at sea. Every one knows that fire is one of the great hazards, not only at sea but also in the air and ashore. When the *Morro Castle* was built four years ago, specially treated fire-resisting materials were just beginning to become commercially available for use in passenger spaces on ships. At present enough fire-resisting materials are commercially available so that, with the more extensive use of steel and other metals, the fireproof or fire-resisting construction of passenger and crew quarters is not only practicable but economical. The added cost of such fire-resisting construction is not more than two per cent of the total cost of the vessel. Wood and other inflammable materials have already been practically eliminated, on modern vessels, from crew's quarters, galleys, pantries, and on the lower decks, so that, except in passenger accommodations, the fire hazard has been greatly reduced.

On the newest American ships, practically all bulkheads in the passenger spaces are made of fire-resisting materials. In the past, where a passenger vessel has been destroyed by fire, the fire has swept through passenger accommodations with incredible speed. In new ships such possibilities should not exist. A ship should not be built like a palace or a museum; it is a transportation unit and should be designed as such. The atmosphere of luxury, if necessary, should be confined to furnishings of good taste. As background, the ship's structure will be much more successful (assuming an harmonious design) if the passenger has the sense of security which comes from the knowledge that it cannot burst into flame.

SAFETY PRECAUTIONS IN THE DESIGN OF THE MORRO CASTLE

The *Morro Castle* was built to conform in every respect as to subdivision, strength, stability, seaworthiness, and equipment with the Board of Trade Rules for 1928, and although laid down prior to the International Convention on Safety of Life at Sea of 1929, was built in substantial accord with the requirements of that convention. The plans and specifications were approved by the American Bureau of Shipping, the United States Shipping Board, the Steamboat Inspection Service, the Navy Department, and, in so far as the electrical installation was concerned, by the National Board of Fire Underwriters.

Cargo holds were fitted with a smoke-detection system with indicators on the bridge and a foam extinguishing system controlled from the same point. The boiler room was fitted with a foam extinguishing system. Staterooms were equipped with thermostatic detectors operating on any rapid rise in temperature such as might be caused by a fire, no matter how small, in a confined space, with indicators on the bridge. The foam extinguishing system is not practicable for staterooms, for the reason that foam smothering a fire in one room might also smother the occupants of staterooms on the same branch of the system. Nor has it been considered practicable to equip ships with automatic sprinkler systems similar to those used in buildings ashore, although a very few vessels are thus fitted.

As in the case of practically every passenger ship, the public rooms of the *Morro Castle* were not provided with automatic detectors, the discovery of fire depending upon the frequent inspection by watchmen, and its extinction, as in staterooms, being accomplished by hand extinguishers and hose. Fire-screen bulkheads, capable of withstanding a temperature of 1500 F for one hour, extended all the way up through the superstructure, spaced no more than 131 ft apart—usually less, in accordance with partitioning between public rooms—and were fitted with fire-screen doors possessing equal fire-resisting qualities.

THE PROBLEM OF PERSONNEL

As the story of the *Morro Castle* fire is unfolded in the press, in the testimony of survivors of the disaster, and in the official reports, it becomes evident that more is needed to insure safety of life and property than fire-resisting materials and fire-detecting, fire-protecting, and fire-fighting devices. In the development of these the engineer may take a reasonable pride of accomplishment, for in them he has incorporated the lessons of experience and the advances in technology and science. It is evident that, in the last analysis, competent, alert officers and men are even more necessary in emergencies on modern ships than on smaller and more simple craft, and that in the safety devices themselves are those additional hazards that come from a sense of overconfidence and oversecurity and the uselessness of the devices themselves if they are not properly maintained and operated, or if their functions and operation are not understood. Important as the lessons concerning inflammable materials of construction certainly are, therefore, they are eclipsed by thoughts in connection with the lack of training and discipline of the crew of a ship in dealing with an emergency. As in industrial undertakings, it becomes more and more evident that an engineering job is incomplete without constant attention to the problems originating in the personnel and their relation to machinery and mechanical devices, not only in operation, but in maintenance and design as well. The dictum that a machine is not properly designed until it has been made as safe and as foolproof as conditions and the state of technology permit, is particularly valid with respect to ships where hazards and emergencies are grave and are met with overwhelming suddenness.

Ship operators, like other business men, are in business to make money if possible and must see a fair return on every investment. Successful operation of all equipment depends on trained personnel, especially on a ship with its many complicated functions and devices. Resourceful seamen with that

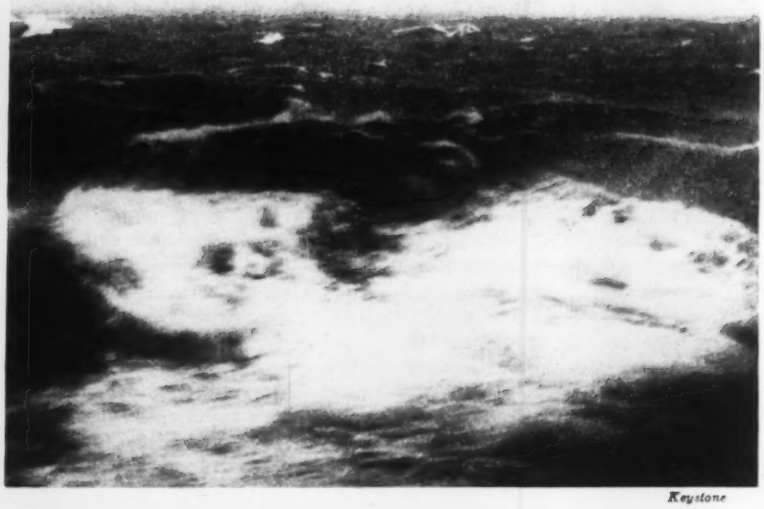
inquiring turn of mind who can reason from effect to cause and devise a remedy when occasion arises will always be needed. Every officer and man on a ship should be both a teacher and a student, a teacher to those below him and a student to those above him. There should be no further place for that type of officer who resents questions, refuses to explain things, and discourages an ambitious learner. Due to the introduction of so much mechanization in industry there is a natural tendency to dull the mental activities of attendants. This is especially true aboard ships where life is quite routine with its watch-standing and tendency toward monotonous existence, much of the time. While we like to make our occupations more comfortable and every man-hour more effective, we must give as much thought to the human side of the situation as we have to the creative design. How shall we make the life of a sailor attractive to the very best type of young men? How much longer must the cadet act, look, and be thought of aboard ship as a "lost soul"? How shall we stimulate and develop these young men into the best possible operatives of these complicated devices on which we send them to sea? We shall achieve our goal of safe and economical marine transportation only after we have succeeded in answering questions such as these.

FIGHTING FIRE AT SEA

To fight fire at sea with any degree of success requires the services of competent men who by constant training, drilling, and actual practise are able to snap into action with military precision and execute orders with no loss of time. Proficiency in this vital work cannot be obtained without executing every detail of it again and again under every sort of condition that is likely to be met on the ship.

The regulations of the National Fire Protection Association governing marine fire hazards contain a valuable recommendation regarding this matter that should be carefully considered by shipowners, and that is that certain members of the crew be designated as fire wardens and trained to special duties, such as the use of smoke helmets and fire-extinguishing apparatus, life saving, etc., and that some form of compensation or privilege be accorded the men so designated. French passenger vessels carrying more than 250 passengers are required to carry a squad of fire specialists, holding a special certificate, under the orders of a security officer, the number varying from three to nine, depending upon the capacity of the passenger accommodations.

If we have found that some officers and men have proved themselves less than capable, may we not remember those fine heroes yet active and alert in the American merchant marine, such as Randall, Grenig, Stedman, Fish, Fried, Miller, Cummings, Moore, and others who by superb seamanship and organization have not only performed splendid rescues of lives at sea, but have kept their own ships safe and secure in the service of transporting passengers and freight?

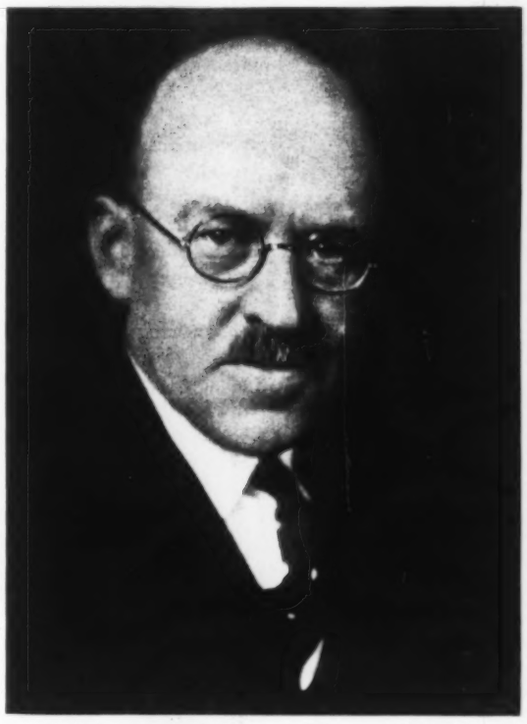


Keystone

The A.S.M.E. ANNUAL MEETING

Clearing Up of Membership Status, Constructive Work of Local Sections' Delegates, Setting Up of Advisory Boards on Technology, Standards and Codes, and Appointment of Secretary C. E. Davies Some of the High Points

THAT bustle of coming and going, of handshaking and hastily snatched conversations, which seems like the ultimate in irrational procedure to the observer who is not a part of it, but is a well-organized and traditional convocation to the older men, at least, who take part in it—the Annual Meeting of The American Society of Mechanical Engineers—took place in New York, December 2 to 7, 1934. The total registration, in excess of 2000 members and guests, was not a record-breaker, but was encouraging to those in charge when it was considered that a recent action of the Council with respect to the status of members in arrears for dues as a result of bad times had reduced the number of active members tremendously, and when it was further remembered that a registration fee of one dollar was collected from non-members registering for the technical sessions. Scenes in the various lobbies, in the rooms of the society, and at the Engineers' Club were reminders of former and better days and gave evidence of the richness and vitality of the spirit of good-fellowship that is one of the most cherished experiences of such gatherings.



RALPH E. FLANDERS, PRESIDENT, 1935
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

In retrospect, to one observer at least, it appears that a much healthier feeling pervades the Society, and that a reasonable spirit of optimism prevails among the members. With the membership greatly reduced by the casualties of the past few years, with most of the misunderstanding on Society procedure and policy cleared up by frank discussion, with finances on a sounder basis, with the results of the searching inquiries of the Committee on Policies and Budget yielding rich dividends in restated objectives and a revised and thoroughgoing program for the immediate future, prospects for the coming year are encouraging.

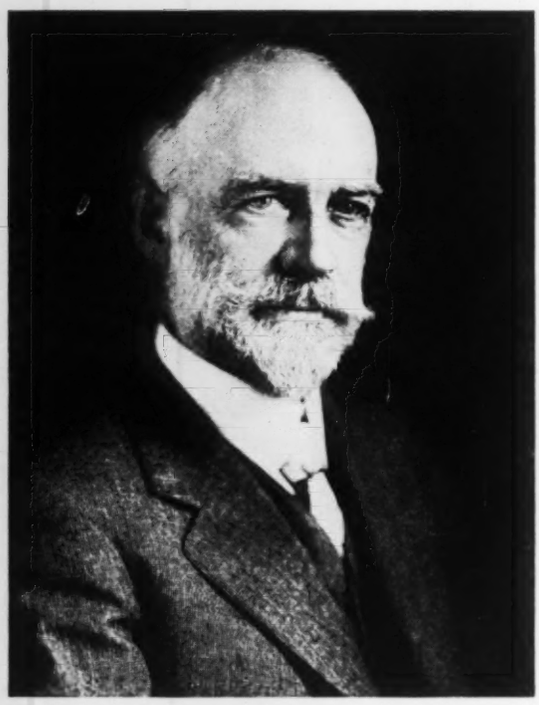
Great promise is held out of the rich benefits that should be derived from increased emphasis that is being placed on the Society's technological activities. In the appointment of two advisory and coordinating committees, one on technology, which will correlate the work in meetings and programs, professional divisions, research, and publications, and the other on standards and codes, with similar functions for these lines of work, a step toward the reorganization of the Society for the better carrying out of the proposed amendment on objectives has been taken. In the account of the Council meetings, pages 62 to 64 of this issue, the actions on these Boards and on the objectives will be found.

The Society sustained the heavy and grievous loss of its secretary, Dr. Calvin W. Rice, two months before the Annual Meeting, but his foresight had developed a staff organization whose administrative head was in close touch with all the details of the Society's business and technical affairs. The Council, therefore, found in C. E. Davies a man with the requisite ability, training, and special knowledge to carry on the work of Dr. Rice. Thus the appointment of Mr. Davies to the secretaryship was a logical development, and his taking over of this important post will be accomplished without loss of efficiency or interruption of the Society's work.

LOCAL SECTIONS' DELEGATES CONFERENCE

For the purpose of setting up an exchange of views on matters of Society policy between members in the local sections and the Council and its committees, a conference of delegates from the sections has for many years been a feature of these annual affairs. Last year, as an economy measure, seven group conferences were held prior to the Annual Meeting in centers representing the seven geographical areas into which the United States has been divided for purposes of local-section administration. Copies of committee and Council reports were available at these conferences. The reports were discussed, matters of Society affairs were taken under consideration, in some instances resolutions were passed, and from every conference a delegate was elected to attend a conference of delegates which was held at the time of the Annual Meeting.

This year the same procedure was followed and the annual reports were distributed to members of the Society prior to the Annual Meeting as a supplement to the November issue of Transactions. Instead of one, two delegates were elected from each group conference. These delegates were the following:



WILLIAM F. DURAND

HONORARY MEMBER, A.S.M.E., 1934

Group 1: H. C. Kendall, Worcester, Mass., and C. W. Taylor, Hamden, Conn.

Group 2: J. N. Landis, Brooklyn, N. Y., and R. B. Purdy, New York, N. Y.

Group 3: George E. Crofoot, Philadelphia, Pa., and C. L. Allen, State College, Pa.

Group 4: J. W. Eshelman, Birmingham, Ala., and J. M. Duncan, Hopewell, Va.

Group 5: L. E. Jermy, Cleveland, Ohio, and S. R. Beitler, Columbus, Ohio.

Group 6: E. L. McDonald, Kansas City, Mo., and F. H. Dorner, Milwaukee, Wis.

Group 7: S. R. Dows, Albany, Calif., and W. H. Martin, Corvallis, Ore.

Under the leadership of Jiles W. Haney, chairman of the Committee on Local Sections, these fourteen delegates convened in the Society's council room at 10 a.m. on Sunday, December 2, adjourning for lunch with the Council at 12:30. At its afternoon sessions the Conference met with the Finance Committee, various representatives of the Engineers' Council for Professional Development, and the Committee on Publications. Following a buffet supper at the Engineers' Club, Harry R. Westcott, chairman, Committee on Policies and Budget, called the Conference to order for an evening session and discussed with it the plans and proposals of that committee.

While no further meetings prior to the meeting of the Council had been planned, the delegates felt that their task was to discuss the numerous resolutions that had been passed at the seven group conferences at which they had been elected, decide upon some course of common action, and go before the Council with carefully considered resolutions and recommendations. Hence they met early on Monday morning to transact such business as time allowed and came into the Council meeting later that morning. For the actions of the Council and Executive Committee, see pages 62 to 64.

PRESIDENTS' NIGHT

The first social function of the Annual Meeting was Presidents' Night, which began, for members of the Council, with a dinner at the Engineers' Club. The public meeting was held in the Auditorium following the dinner where the annual address of the president was delivered by President Paul Doty. President Doty's address, in accordance with a traditional procedure, will be published in the Transactions, and, under the new scheme of distributing the Record and Index portions of the Transactions in a number of sections, it will appear early in the year.

President Doty's subject was "The Engineer and Recovery." He said that the mechanical engineer was vitally interested in any rational program for national recovery, and that, as the "society of the industries," the work of the A.S.M.E. was primarily in the durable-goods field. Hence any program which would stimulate the Society's professional divisions and their activities, put people back to work, and restore prosperity to the durable-goods industries and to the nation, was assumed to be of interest to the mechanical engineer.

He then offered a brief survey of recent progress in the fields of the A.S.M.E. professional divisions and related engineering activities.

President Doty next turned his attention to the importance of renovizing and modernizing, referring in this connection to the activities of the Home Owners' Loan Corporation and to the possibility of putting depreciation reserves to work. He estimated that at least three billions of dollars of industrial depreciation reserves could be expended at the present time, and expressed the view that such reserves are "premiums to maintain the life of the property in good health and in 100 per cent condition of usefulness."

Speaking of Society affairs, President Doty said that its financial house had been put in order, and reviewed briefly some of the accomplishments of his administration. He concluded by expressing the hope that his address would provoke in the minds of engineers a sense of the ungrasped opportunities that were ahead. "Believing in cooperation," he said, "the mechanical engineer challenges the courageous leaders of industry and appeals to the far-sighted investor of faith to take advantage now of the far-reaching possibilities of industrial reconditioning as a means of recovery of national welfare."

At the conclusion of President Doty's address the tellers of election of officers for 1934–1935 reported and President-Elect Ralph E. Flanders was introduced.

The Society's Junior Award was conferred on John I. Yellott, Jr., instructor in mechanical engineering, Stevens Institute of Technology, for his paper on "Supersaturated Steam."

Dean Dexter S. Kimball, past-president, then introduced Dr. William F. Durand, past-president, upon whom honorary membership in the Society was conferred by vote of the Council. Geo. A. Orrok introduced Dr. D. S. Jacobus, past-president, for a similar honor.

The exercises were followed by a reception and dancing.

DR. DURAND'S USEFUL CAREER

Dean Kimball's gracious speech delivered when he presented Dr. Durand was, unfortunately, not recorded.

Dr. William F. Durand was born in Bethany, Conn., on March 5, 1859, and was graduated in 1880 from the United States Naval Academy. After seven years of service in the Engineers Corps, he resigned, in 1887, to take up teaching as a profession, first at the Michigan State Agricultural College, where he was professor of mechanical engineering until 1891, and then at Cornell, where he was professor of marine engineer-

ing until June, 1904. In 1904 he went to Stanford University where he was professor of mechanical engineering until June, 1924, when he was placed on the emeritus roll. He served as president of the A.S.M.E. in 1924–1925, and will long be remembered for his brilliant handling of the duties of toastmaster at the Fiftieth Anniversary dinner in Washington.

During the War, Dr. Durand served in Washington as chairman of the National Advisory Committee for Aeronautics, and vice-chairman of the National Research Council Committee on Engineering. In 1918, he was in Paris as Scientific Attaché to the United States Embassy, and also as a member of the Inter-allied Commission on War Inventions. In 1925, he was appointed by President Coolidge a member of the President's Aircraft Board and served that Board as member and secretary. In 1929, he was appointed to the Advisory Board of Engineers on the Boulder dam project.

Dr. Durand is the author of books on mechanics, the resistance and propulsion of ships, marine engineering, the hydraulics of pipe lines, and the Biography of Robert Henry Thurston, of the A.S.M.E. biographical series, in addition to many papers published in governmental reports and the technical press. At present he is editor of a series of six volumes, of which one has been published by Julius Springer, Berlin, on "Aerodynamic Theory," a general review of progress under the Guggenheim Fund for the Promotion of Aeronautics.

Dr. Durand is a member of many scientific, learned, and engineering societies in this country and abroad and gold medalist of the American Society of Naval Engineers.

D. S. JACOBUS

HONORARY MEMBER, A.S.M.E., 1934

GEO. A. ORROK'S TRIBUTE TO D. S. JACOBUS

In presenting Dr. Jacobus, Mr. Orrok said: "It becomes my duty, as it is my pleasure, to present to your notice a candidate for honorary membership in our Society.

"Born in 1862 in New Jersey, graduated from Stevens Institute of technology in 1884 under the auspices of Morton and Thurston, he joined the faculty of the Institute as assistant, then professor of experimental engineering and successor to our first president; manager of the society in 1900, vice-president in 1903, president in 1915–1916; and the recipient of the honorary degree of doctor of engineering from Stevens in 1906. He became advisory engineer of the Babcock and Wilcox Co. in 1906, which position he still holds. He has been honored by membership in many societies such as the American Society of Naval Architects and Marine Engineers, American Institute of Mining Engineers, American Mathematical Society, American Institute of Electrical Engineers, Franklin Institute, American Society of Refrigerating Engineers, of which he was president in 1906, and the American Welding Society, which he served as president in 1934.

"As professor of experimental engineering he followed the tradition of Hoadley, who applied the calorimeter to boiler testing, and of Thurston, this Society's past-president, and takes rank for the accuracy and extent of his testing experience with Unwin, Donkin, and Kennedy, who represent the standard of excellence in Great Britain. He has been adviser to the Boiler Code Committee from the first, and vice-chairman and chairman of its executive committee since 1917, and has served on the Power Test Code Committee since its inception in 1918, besides work on many other of our committees. But all this does not express the unique position which he occupies in the field of mechanical engineering, for when the subject of steam has been mentioned in the last twenty-five years, his name was immediately before us as the foremost authority in this country. The Society has honored his predecessors, Hirn and Clausius in 1882, Dwelshauvers-Dery in 1886, Isherwood in 1894, and Unwin in 1898. It now, in 1934, delights in honoring David Schenck Jacobus, teacher, scientist, engineer, and greatly loved friend of all who know him."

THE ANNUAL DINNER

In accordance with a custom of long standing, the Annual Dinner to New Members was held in the Grand Ballroom of the Hotel Astor on Wednesday evening. Presiding at the dinner as toastmaster was William L. Batt, member of council, past-chairman of the Committee on Meetings and Program, and president of the SKF Industries. Mr. Batt's friendly, gracious, and polished performance as toastmaster set a high standard that will long be remembered.

Following the dinner, C. E. Davies called the roll of new members to whom greetings were delivered by Past-President A. A. Potter. Dean Potter said: "As I rise to welcome the new members to our Society, there is brought back to my recollection the 1931 Annual Dinner when it was my privilege to perform a similar task. That particular event stands out very clearly in my memory, as on the same evening my dear friend and good counselor was made an honorary member of the A.S.M.E. I am referring to Dr. Calvin W. Rice whose unselfish devotion to his profession and to his friends has always been an inspiration to thousands of engineers.

"Dr. Rice always regarded membership in The American Society of Mechanical Engineers a public service involving great responsibilities as well as splendid opportunities for outstanding service to humanity. His breadth of vision for the engineer, always in terms of cooperation and social obligations, will, I hope, be your guide as members of the A.S.M.E. In greeting you, our new associates, I wish to assure you that you will find membership in our Society a distinct opportunity to add to the prestige of your profession by cooperating with others in connection with the solution of problems of value to the public. I am also confident that your new affiliation will add to your personal pleasure through the friendships which you are bound to form among the members. My congratula-

WILLIS H. CARRIER

RECIPIENT OF A.S.M.E. MEDAL FOR 1934

tions to you as members of The American Society of Mechanical Engineers."

PRESENTATION OF MEDALS

Fifty-year badges to all those for whom 1934 marked the culmination of fifty years of membership in the A.S.M.E. were presented to the following: Gardner C. Anthony, Mortimer E. Cooley, Henry A. DuVillard, Alfred E. Hammer, William T. Magruder, Thomas F. Rowland, Jr., Thomas C. Sheldon, and Erwin W. Thompson. Of this group, Mr. Henry A. DuVillard and Prof. William T. Magruder were present.

Roy V. Wright, past-president, then presented for the A.S.M.E. Gold Medal, Willis H. Carrier, chairman of the Board of the Carrier Corporation, Newark, N. J., in recognition of his research and development work in air-conditioning; and Ambrose Swasey, past-president and honorary member, patron and founder of the Engineering Foundation, and life-long friend and partner of the man for whom the medal was named, presented Ralph E. Flanders, president-elect of the Society, for the Worcester Reed Warner Medal, "for his contributions to a better understanding of the relationship of the engineer to economic problems and social trends as exemplified by the many papers which he has presented." A biographical sketch of Mr. Flander's career will be found on page 503 of the August, 1934, issue of MECHANICAL ENGINEERING.

W. H. CARRIER, PIONEER IN AIR-CONDITIONING

Willis H. Carrier is a native of Angola, N. Y., where his early education was received. He was graduated from Cornell with honors in 1901, and entered the research department of the Buffalo Forge Co., manufacturers of fans and heaters. In 1906 he became chief engineer of that company. During his years of service he contributed to the design of the "conoidal" fan, and to rational and accurate methods of estimating the capacity of heating surfaces in relation to air velocities. His work early drew him to a consideration of the problem of moisture in the atmosphere, and to methods of measuring and controlling it, from which his later work in air-conditioning received its start. In 1911 he presented his now classic paper, "Rational Psychrometric Formulae," to the A.S.M.E. Among his inventions is the differential hygrostat for humidity control.

With his friend and associate, J. Irwin Lyle, and six other men, Mr. Carrier founded the Carrier Engineering Corporation in 1915, which has since been notably engaged in air-conditioning engineering. One of Mr. Carrier's inventions is the centrifugal refrigeration machine which uses a harmless refrigerant so that its application to the air-conditioning systems of public buildings is attended with the minimum of hazard. He has contributed to the engineering literature on subjects relating to heating and ventilation, refrigeration, and air-conditioning. He is a member of the A.S.H.&V.E. and a past-president of the A.S.R.E.

H. V. KALTENBORN ON "THE WORLD IN REVOLUTION"

At the conclusion of the presentation of awards, H. V. Kaltenborn, world news commentator, was introduced as the speaker of the evening. The subject of his address was "The World in Revolution." Mr. Kaltenborn's address was delivered in his familiar radio style and covered the events of the recent past that reflected conditions in all of the principal countries of the world. He emphasized the inevitable world-wide viewpoint that had been brought about by progress in invention. Following a brief review of foreign affairs, Mr. Kaltenborn directed attention to internal affairs and particularly to what was going on in Washington. He expressed his disbelief in war in the near future on the basis that war would result in revolution and that, as a result of the growth of knowledge and easy communication, common sense and a sense of reality were developing in the world.

At the conclusion of Mr. Kaltenborn's address, the floor was cleared and dancing continued until a late hour.

MEMORIAL LECTURES

To the usual features of the Annual Meeting that have been known as the Towne and Thurston lectures, the Calvin W. Rice lecture was added this year. This most inspiring and thoughtful address emphasizing Calvin W. Rice's contributions to international friendliness, was delivered on Wednesday afternoon by Dr. John H. Finley, editor, *New York Times*. Dr. Finley spoke of the contributions to civilization that engineers had made and read several excerpts from letters of prominent men with whom Dr. Rice had come in contact in his interests in foreign students and engineers and in his efforts to forward many projects of international cooperation. Dr. Finley expressed the hope that he was delivering what would be the first of a series of lectures to commemorate Dr. Rice's life and work and to deal with the relationships of engineers and international friendliness and understanding.

The Robert Henry Thurston lecture on the relations of science and engineering, in memory of the first president of the A.S.M.E., was delivered on Tuesday by Dr. John Johnston, Director of Research, United States Steel Corporation. It is hoped that Dr. Johnston's interesting and ably presented address will be published in the February issue of MECHANICAL ENGINEERING, and hence no attempt to summarize it will be made here. Dr. Johnston's subject was, "Some Applications of Science to the Making and Finishing of Steel."

The Henry Robinson Towne Lecture, on engineering and economics, was delivered by Dexter S. Kimball, past-president, as part of the exercises held at the Stevens Institute of Technology in honor of Henry L. Gantt. The address, "Prophets and Panaceas," appears as the leading article of this issue.

STUDENT-BRANCH LUNCHEON

On Wednesday at noon, representatives of the A.S.M.E. Student Branches, honorary chairmen of the branches, members of Council, and about fifty well-known members of the Society met for luncheon with the Committee on Relations With Colleges, President Doty, and President-Elect Flanders. Prof. E. F. Church, Jr., of Brooklyn Polytechnic Institute, chairman of the committee, presided.

President Doty presented the Student Award, a certificate and a prize of $25, to H. Reynolds Hudson, undergraduate of the Georgia School of Technology, for his paper, "Dynamic Balance and Functional Utility Applied to Automotive Design." To Mr. Hudson's mother, Eugene W. O'Brien, member of Council, presented one of the Society's biographies which had been suitably inscribed.

On Philip P. Self, of the Colorado Agricultural College, Ft. Collins, Colo., was conferred the Chas. T. Main Award for his paper, "Air-Conditioning, Its Practicability and Relation to Public Welfare." Mr. Self was not present, and Prof. John A. Hunter, of the University of Colorado, member of Council, received the certificate and award of $150 from President Doty and will present them later to the prize winner. The award was established in 1919 from a fund created by Charles T. Main, of Boston, past-president of the Society, to be awarded to a student of engineering, preferably a member of a student branch of the Society, for the best paper within the general subject of "The Influence of the Profession Upon Public Life."

Wallace Clark, consulting management engineer with extensive practise in Europe, spoke on the opportunity for engineers abroad. He confined his remarks to the general type of work in which he was engaged and gave to his hearers the benefit of some of his experiences. He emphasized the difficulties of doing business through an interpreter, as was necessary with any extensive relationships in Europe.

COUNCIL AND BUSINESS MEETINGS

Following the plan used last year, the Council met on Monday morning and invited members of the Conference of Local Sections' Delegates, chairmen of society committees, and other members interested in the Society's affairs to sit with it. President Doty presided and paid a brief tribute to Dr. Calvin W. Rice.

Reports of committees were presented by roll-call and received by the Council. Actions taken by the Council are reported elsewhere in this issue (see pp. 62–64). The meeting adjourned for lunch and reconvened Monday evening when an opportunity was presented to hear C. F. Hirshfeld, chairman, E.C.P.D., and George T. Seabury, secretary, Am.Soc.C.E., and newly elected secretary, E.C.P.D., report on the Engineers' Council for Professional Development. John F. Coleman, president, and Frederick M. Feiker, executive secretary, of the American Engineering Council, spoke on the work of that organization.

The annual business meeting of the Society was held in the Auditorium on Monday afternoon. President Doty presided over an audience in excess of one hundred.

TRIBUTE TO CALVIN W. RICE

A tribute to Dr. Calvin W. Rice, for twenty-seven years secretary of the Society, whose death occurred in October, was presented in behalf of the committee of three past-presidents, Dexter S. Kimball, chairman, D. S. Jacobus, and Alex Dow, appointed for this purpose at the October 24 meeting of the Executive Committee. The tribute follows:

JOHN JOHNSTON

ROBERT HENRY THURSTON LECTURER, 1934

In the passing of Calvin Winsor Rice this Society has suffered an irreparable loss and many of its members have lost a kind friend and a wise adviser. To some of us who have been close to him for many years it does not seem possible that we shall never again see his cheerful smile, never again feel the hearty clasp of his hand, and never again see his bold signature at the end of a letter.

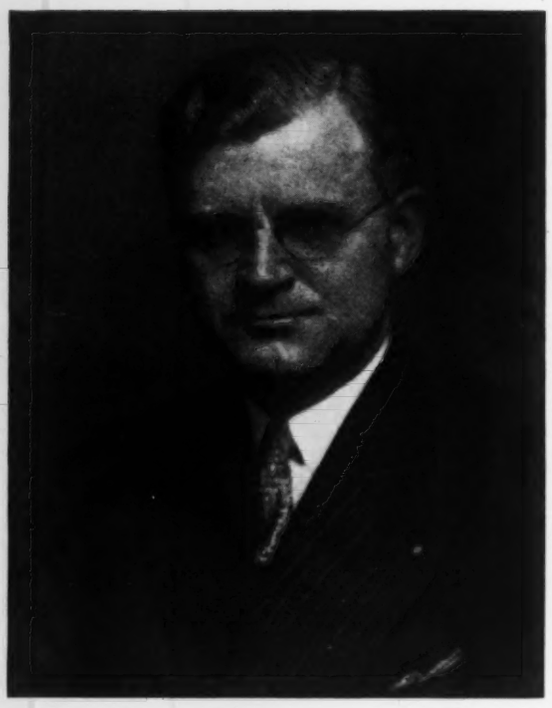
The accomplishments of his long and busy life are well known and will be recorded elsewhere, but it is very fitting that we should here be reminded of the great work that he performed in building up this Society. In season and out of season he labored wholeheartedly, and much of the success and reputation of The American Society of Mechanical Engineers is due to his foresight and faithfulness. Nor has this Society alone been benefited by his work. He had long been a source of information and inspiration to all who were concerned with the affairs of the engineering profession.

Especially should we remember that the existence of the Engineering Societies Building that has done so much to stimulate and consolidate the engineering fraternity is largely the result of his enthusiasm and diplomacy. As a consistent and energetic promoter of the life within the walls of this building, his work has been preeminent and will ever be remembered.

Mr. Rice was a man of remarkably broad and sympathetic nature. All good works claimed his attention and support and his range of activities was surprisingly great, both in this country and abroad. As a natural result he had a world-wide host of friends and acquaintances. He had indeed a peculiar ability to make friends of all manner of men. Few men in any walk of life have made so many personal contacts as he, and this in no small way redounded to the credit and reputation of the Society. The loss of these many connections can never be regained.

He was particularly considerate of young men and their problems. Many such sought him out for the advice and help that never failed and which was given freely and graciously. His unfailing good humor and his patience, diplomacy, and steadfastness, even when under criticism, fitted him admirably for the great work that he accomplished as secretary of the Society.

The engineering fraternity has lost a distinguished member, the Society has lost a great leader, and many of us have lost a friend and counselor. Because of such men the race makes progress, and the world is the better for his presence. And his work will endure. The labors



C. E. DAVIES

A.S.M.E. SECRETARY

of no man, who builds so intelligently and industriously as he, are ever lost but become a part of the inheritance of the race. "Though he were dead, yet shall he live." It is for those of us who remain to build upon the work he directed, so long and so well, the greater and more serviceable society that he always visualized, weaving into it not only technical excellence, but also the fine human qualities that so marked his personality.

"Build thee more stately mansions, O my Soul!
As the swift seasons roll!
Leave thy low-vaulted past!
Let each new temple, nobler than the last,
Shut thee from heaven with a dome more vast,
Till thou at length art free,
Leaving thine outgrown shell by life's unresting sea!"

REPORTS OF COMMITTEES

Following the reading of the tribute and resolutions, which were adopted unanimously, President Doty read the preface of the Council report. The report of the Finance Committee was presented by Harold V. Coes, that of the Committee on Publications by L. C. Morrow, that of the Committee on Policies and Budget by Harry R. Westcott, that of the Capital-Goods Industries Committee (see pages 9 to 14 of this issue) by L. P. Alford, and that on the Employment Program by W. A. Shoudy. It is expected that the recommendations contained in the report on the employment program will be published in a later issue and hence they will not be reviewed here. John F. Coleman, president, American Engineering Council spoke on the work of that organization, and C. F. Hirshfeld, chairman, E.C.P.D., presented a report on the progress being made by that body. By vote of the meeting the various reports were approved.

Jiles W. Haney, chairman, Committee on Local Sections, announced the personnel of the Nominating Committee for 1935. The committee is constituted as follows:

Group 1: W. K. Simpson, Waterbury, Conn.; C. H. Berry, Cambridge, Mass., alternate.

Group 2: A. D. Blake, New York, N. Y.; E. A. Kerbey, New York, N. Y., alternate.

Group 3: A. G. Christie, Baltimore, Md.; A. R. Stevenson, Jr., first alternate; F. V. Larkin, Bethlehem, Pa., second alternate.

Group 4: B. R. Van Leer, Gainesville, Fla.; R. P. Kolb, Raleigh, N. C., alternate.

Group 5: A. N. Goddard, Detroit, Mich.; F. W. Marquis, Columbus, Ohio, alternate.

Group 6: F. H. Dorner, Milwaukee, Wis.; A. A. Luebs, Lincoln, Neb., alternate.

Group 7: R. L. Daugherty, Pasadena, Calif.; H. P. Vail, Los Angeles, first alternate, R. R. Robertson, Los Angeles, second alternate.

C. E. DAVIES APPOINTED SECRETARY

One of the first acts of the new Council at its meeting on Friday was to name the two appointive officers, secretary and treasurer. Erik Oberg was reappointed treasurer.

C. E. Davies, since 1931 executive secretary of The American Society of Mechanical Engineers, was appointed national secretary of the Society. He succeeds Dr. Calvin W. Rice, whose death in October of this year terminated twenty-seven years of active service as national secretary. With Mr. Davies' appointment, the offices of secretary and executive secretary were combined.

Mr. Davies, a member of the staff of the Society since 1920, was born in Utica, N. Y., and received his early education at the Utica Free Academy, from which he was graduated in 1907. In 1910 he entered Rensselaer Polytechnic Institute, Troy, N. Y. He was elected to the honor societies of Tau Beta Pi and Sigma Xi, and he received the degree of mechanical engineer from the Institute in 1914.

Mr. Davies began his professional career in the production department of the Smith Premier Works, Syracuse, N. Y., of the Remington Typewriter Company. Here he came in contact with Henry L. Gantt, one of the pioneers in industrial management.

During the War, as first lieutenant and later as captain, Mr. Davies served in the Ordnance Department, U. S. Army, being assigned to the Frankford Arsenal, where he was responsible for developing methods of manufacture and production-control schemes for the manufacture of artillery ammunition, and later for the operation of the fuse shop at that arsenal. Since the War he has maintained active contact with the Ordnance Reserve of the U. S. Army, participating in the organization and operation of the N. Y. Ordnance District. He holds the rank of lieutenant-colonel in the Ordnance Reserve Corps.

At the close of the War, Mr. Davies returned to the Remington Typewriter Company at the works in Ilion, N. Y., and later at the Syracuse works.

In 1920 he became associate editor of The American Society of Mechanical Engineers, and in 1921, managing editor and assistant secretary of the Society. Under his supervision were the activities of society administrative committees responsible for the meetings and publications of the Society. Mr. Davies was later placed in charge of the administration of the headquarters office, and in 1931 was appointed executive secretary.

He is honorary corresponding secretary for North America of the Newcomen Society (England) for the study of the history of engineering. He was the first secretary of the Engineers' Council for Professional Development, a conference of engineering, educational, and licensing bodies.

Mr. Davies is treasurer of the Gantt Medal Board of Award of The American Society of Mechanical Engineers and the Institute of Management. He is chairman of the District Scholar-

ship Committee of Pi Kappa Phi, and a member of the Council of the Society for the Promotion of Engineering Education. He is also chairman of the alumni committee and a member of the national executive committee of the Society of Sigma Xi, honorary scientific body.

He is president of the Gipsy Trail Club, Carmel, N. Y., and served for one year on the Board of the University Glee Club, New York, of which he is a member.

Mr. Davies is a fellow of the American Association for the Advancement of Science and a member of the Institute of Management, the American Management Association, the American Association for Adult Education, the Reserve Officers Association, and the Army Ordnance Association. He is a member of the Engineers' Club, New York, and the Cosmos Club, Washington, D. C.

JUNIOR GROUP MEETING

On Monday evening, the Junior Group of the A.S.M.E. Metropolitan Section held its second anniversary meeting. Three papers on the young engineer and the New Deal were presented. The papers were written and delivered by three of the junior members. The first, by George L. Williamson, dealt with the history of the subject, the second, by Richard Stoltzing, with the present situation, and the third, by Arthur C. Stern, with future possibilities.

A number of the senior members of the Society well versed in various phases of the New Deal presented discussions, among whom were L. P. Alford, Prof. W. R. Woolrich, Prof. Walter Rautenstrauch, and F. M. Feiker. The session was attended by approximately 400 members and was presided over by Ralph Behr, chairman of the program committee of the Junior Group. C. A. Hescheles, general chairman of the Junior Group was introduced and spoke on the value of friendship and discussion, which were made possible through the work of the Junior Group. T. E. Keating, representative of the Metropolitan Section on the Junior Committee, spoke on the value of participation in the Junior movement.

EXERCISES AT STEVENS INSTITUTE

Last year, it will be recalled, some of the exercises of the Annual Meeting were held at Stevens Institute of Technology because of the fact that Frederick W. Taylor, past-president of the Society, had been graduated from that institution 50 years before. This year marked the fiftieth anniversary of the graduation of Henry L. Gantt, pioneer consulting engineer in industrial management and during his lifetime active in the presentation and discussion of papers on management subjects before the A.S.M.E. Hence it was thought appropriate to hold certain sessions of the Annual Meeting in Hoboken, and to arrange for the delivery of the Towne lecture and the presentation of the Gantt medals at that time.

The Thursday afternoon session on economics under the auspices of the Management Division was therefore held in the Stevens Auditorium, Dr. Harvey N. Davis, president, Stevens Institute of Technology, presiding. The principal speaker was George H. Houston, president, Baldwin Locomotive Works, Philadelphia, Pa., and chairman of the Durable Goods Industries Committee of the NRA code authorities. Mr. Houston's address is printed elsewhere in this issue (see pages 15 to 21.)

At 6:30 a subscription dinner was served at Stevens Castle. L. P. Alford, author of "Henry Laurence Gantt—Leader in Industry," recently published by Harper & Brothers as one of the series of A.S.M.E. biographies, spoke of Mr. Gantt's life and work, laying particular stress on his philosophy of production and his warning that the world's economic ills were erroneously laid to overproduction.

WALLACE CLARK

RECIPIENT OF GANTT MEDAL FOR 1933

After the audience had reassembled in the Stevens Auditorium, with President Doty presiding, J. W. Roe, chairman of the Gantt Medal Board of Award, took charge of the exercises in which the Gantt Medals for 1933 and 1934 were presented to Wallace Clark and Horace B. Cheney, respectively.

The Gantt Gold Medal was established in 1929 through a fund raised by friends of Mr. Gantt "to memorialize the achievements of this great management engineer, industrial leader, and humanitarian." The fund is in the custody of the Institute of Management, whose representatives, with those appointed by the A.S.M.E. Management Division, make the award annually for "distinguished achievement in industrial management as a service to the community."

RECIPIENTS OF GANTT MEDAL

Because of the absence from the country last year of Wallace Clark, the award to him of the 1933 medal was postponed until this year. Dr. Lillian M. Gilbreth presented Mr. Clark for the award, which was made "in recognition of his distinguished services in the development and promotion of scientific management both in the United States and abroad."

Wallace Clark is a native of Cincinnati, Ohio, and a graduate, in 1902, of the University of Cincinnati. Following ten years of service with the Remington Typewriter Co., Mr. Clark became a staff engineer with Henry L. Gantt in 1917. He was head of the scheduling division of the United States Shipping Board in 1918 and since 1920 has been a consulting management engineer. In 1926 he served as engineering member of the Kemmerer Finance Commission to Poland, for which he was decorated Commander of the Cross of Poland Restored. He is author of books on the Gantt chart, on shop and office forms, on the foreman and his job, on plant layout, on the salt and tobacco monopolies in Poland, and co-author of reports to President Hoover on Patent Office procedure and to the American Engineering Council on the organization of a proposed Federal Department of Public Works and Domain. He has offices

HORACE B. CHENEY

RECIPIENT OF GANTT MEDAL FOR 1934

in New York and in Paris, and much of his work is carried on abroad.

Horace B. Cheney, medalist for 1934, was presented by Col. Malcolm Rorty in recognition of his distinguished industrial leadership and his part in making possible Mr. Gantt's notable work at the Cheney Mills, in supporting him in its developments, and in its maintenance through the succeeding years.

Since 1931 Mr. Cheney has been general manager of the mill and vice-president of Cheney Brothers, South Manchester, Conn. He was the executive in charge of the installation at Cheney Brothers of methods of management represented by Mr. Gantt. Through Mr. Cheney's unfailing adherence to the principles laid down by Mr. Gantt, and his success in adapting these principles to changing conditions, the Gantt system achieved a conspicuous success at Cheney Brothers. His personal contributions have been in the field of fair job assignments, studies of interference, and watching time and quality standards.

Following the presentation of the medals, Dexter S. Kimball, past-president of the Society, delivered the Henry Robinson Towne lecture. His subject was "Prophets and Panaceas." The address will be found on pages 5 to 8 of this issue.

TECHNICAL SESSIONS

It seems anomalous to prepare a report on an annual meeting of an engineering society and to devote such brief mention as must be made here to the technical sessions. However, an adequate treatment of the papers and discussion would require more time and space than is available.

This year, the 36 technical sessions were concentrated on Tuesday, Wednesday, and Thursday. A program of the meeting was prepared in which appeared brief abstracts of the papers. These were devoted to aeronautics, applied mechanics, education and training for the industries, fuels and steam power, iron and steel, machine-shop practise, management, oil and gas power, power test codes, process industries, railroad engineering, research, industrial safety, and textiles, and were sponsored by the professional divisions or special committees to whom such subjects are of special interest.

Because the Transactions is now being issued monthly, it was possible to print in advance of the meeting as many papers as had been received in time for such treatment. Others have appeared in MECHANICAL ENGINEERING, and it is hoped that still others will be published in future issues of these publications. Discussions of papers appearing in Transactions and MECHANICAL ENGINEERING will be found in future issues as soon as opportunity for publication develops. Approximately 100 papers and reports were presented.

TECHNICAL COMMITTEE MEETINGS

This year a further increase in interest was shown in the technical committee meetings. Forty meetings were held: research 15, standards 13, power test codes 7, safety 3, and A.S.T.M. 2. The total attendance at these meetings was 541.

STANDARDS

The annual meeting of the Sectional Committee on Small Tools and Machine Tool Elements, C. W. Spicer, chairman, was held on Wednesday. Reports from all of its 19 technical committees were received and accepted after discussion. The discussion at the meeting revealed the possibility of the standardization of reamers and hobs. Hence the executive committee was authorized to organize technical committees for these projects if further inquiry should confirm the need. During the week well-attended meetings were held also by the following four technical committees of this group: Nomenclature, Rotating Tool Shanks, Machine Tapers, and Cut and Ground Thread Taps. The last named committee practically completed at this meeting a revision of the American Standard which was approved and published in April, 1930.

An important meeting in the bolt, nut, and rivet group was that of Subcommittee No. 1 on Large and Small Rivets. Lieut-Com. R. N. S. Baker, chairman. At this meeting the last step was taken in the development of an American Standard for large rivets. For the past two years the American Institute of Bolt, Nut, and Rivet Manufacturers has been investigating the posssibilities of the cold-forming of the various suggested designs of the high-button-head rivet. With the completion of this study the way to a generally accepted standard seems clear. At a meeting of Subcommittee No. 5 of this group plans were laid for a revision of the present American Tentative Standard for Round Unslotted-Head Bolts.

The measurement and designation of quality of surface is one of the pressing problems in the metal-cutting and finishing industry. This accounts for enthusiastic meetings of two subcommittees of the Sectional Committee on Classification and Designation of Surface Qualities, Lieut-Col. C. G. Mettler, chairman, the first is dealing with the standardization of surfaces produced by tools and abrasives and the second with ways, means, and apparatus for measuring quality of surface. The chairmen of these subcommittees are John Cetrule and J. R. Weaver, respectively. Numerous samples of metal surfaces produced in various ways in the machine shop were exhibited by J. S. Chafee and others, and a large amount of progress toward the establishment of an American Standard was recorded.

Fourteen specialists on the production and gaging of metal parts for cylindrical fits discussed for three hours the proposed revision of the present American Standard for Tolerances, Allowances, and Gages for Metal Fits, which was originally approved and published in 1925. R. E. W. Harrison is chairman of this Subcommittee on Tolerance Systems.

Good progress was made toward the development of a standard for engineering and scientific graphs by a subgroup of Subcommittee No. 4 on Engineering and Scientific Graphs. H. F. Dodge and W. A. Shewhart are chairmen of the subgroup and subcommittee, respectively. The committee meeting was held at the Bell Telephone Laboratories.

This year thirty-nine attended the always popular standards luncheon which was held on Wednesday. Prof. Earle Buckingham, the retiring chairman of the A.S.M.E. Standardization Committee, presided. A meeting of that committee preceded the luncheon at which it was decided to recommend the appointment of Prof. O. A. Leutwiler, of the University of Illinois, as the new member of the Standardization Committee. This appointment was later made by President Flanders. C. W. Spicer was elected chairman for the coming year.

ACCIDENT PREVENTION AND INDUSTRIAL HEALTH

Two outstanding events within the scope of the Safety Committee's field of activity were (1) the technical session on engineering aspects of the prevention of occupational disease disability, held on Tuesday afternoon, and (2) the meeting of the Sectional Committee on a Code for Pressure Piping.

At the first of these meetings five papers dealing with the general subject of occupational disease disability were read by authorities on the several phases of the subject and were freely discussed. W. M. Graff presided at this session. It is expected that these papers will be published in MECHANICAL ENGINEERING.

The final discussion of the proposed American Tentative Standard for Pressure Piping occupied the attention of 60 members of the committee for four hours on Wednesday afternoon. This code will be submitted shortly by the Sectional Committee, of which E. B. Ricketts is chairman, to the A.S.M.E. in its capacity as sponsor for approval and transmission to the American Standards Association.

The A.S.M.E. Safety Committee at its annual meeting elected Mr. W. M. Graff to the chairmanship to succeed T. A. Walsh, Jr., whose term of office expired on December 7.

A meeting of the Joint A.P.I.-A.S.M.E. on Code for Unfired Pressure Vessels, Walter Samans, chairman, was held on Saturday at the headquarters of the American Petroleum Institute. This is the first meeting of the committee since the publication of the code in September, 1934. The principal item of business was a consideration of the reaction of industry to the new code and the formulation of a statement covering its application.

POWER TEST CODES

The power-test-code group of committees held seven committee meetings throughout the week, a series which concluded with the meeting of the main committee on Friday morning. Tuesday was devoted to the subject of fan testing. In the morning the subcommittee, Prof. M. C. Stuart, chairman, sponsored a technical session and in the afternoon the committee held its annual meeting. That same afternoon Power Test Code Committee No. 18 on Hydraulic Prime Movers, E. C. Hutchinson, chairman, held the first of two meetings which it plans to hold this winter. The second meeting will be held on January 16, 1935, during the annual meeting of the American Society of Civil Engineers.

This year a new committee was organized within this group. It is to be known as Committee No. 21 on Dust Separating Apparatus. All but one of the 14 members of this committee were present at the organization meeting held on Wednesday and M. D. Engle was elected chairman. The Committee confirmed the importance and the present need for the setting up of a standard method for the testing of these devices.

JOHN T. YELLOTT, JR.

RECIPIENT OF A.S.M.E. JUNIOR AWARD, 1934

Well-attended meetings are reported also by Committee No. 6 on Steam Turbines, Prof. C. Harold Berry, chairman, and Committee No. 11 on Complete Steam Power Plants, F. M. Van Deventer, chairman.

Routine business having to do with the work of the 21 committees of this group occupied most of the time of the main Committee on Power Test Codes Friday morning. Progress reports were presented by nine committees which have work underway at present.

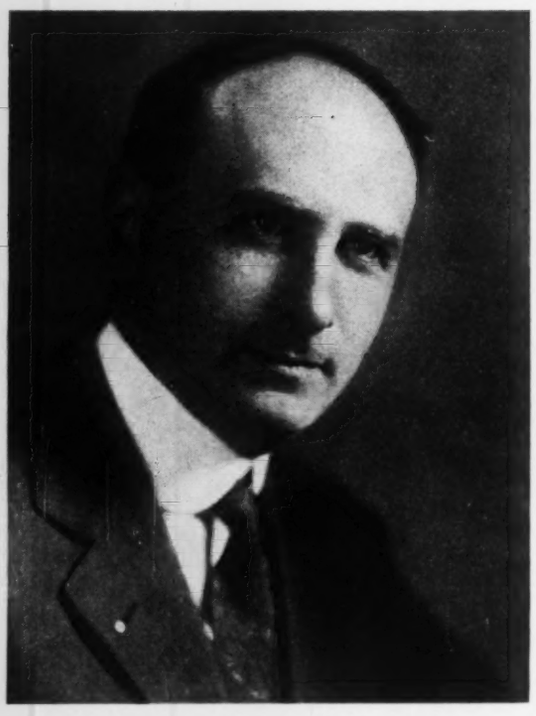
W. A. Carter made a full report on the meeting of the International Standards Association Committee No. 30 on the Measurement of Fluid Flow. Mr. Carter attended this meeting in September, 1934, which was held in Stockholm. He reported also the progress made at a meeting of his subcommittee No. 19 which is preparing a report for the main committee on the standardization of the form and dimensions of flow nozzles and orifices, together with a standard procedure for their use in flow measurements.

Dr. R. H. Fernald was elected acting chairman of the main Committee on Power Test Codes, of which Dr. Fred R. Low is chairman.

RESEARCH ACTIVITIES

A total attendance of 170 was recorded at the meetings called by 15 of the Society's special and joint research committees during the 1934 A.S.M.E. Annual Meeting. Several of these committees also reported the technical results of their work during the past year in papers read at six of the technical sessions. Twenty reports and related papers were contributed to the Annual Meeting program in this way.

George M. Eaton, director of research, Spang Chalfant Co., was elected chairman of the A.S.M.E. Main Research Committee to succeed Alex D. Bailey. President Flanders announced the appointment of Nevin E. Funk, vice-president,



A. A. POTTER
CHAIRMAN, ADVISORY BOARD ON TECHNOLOGY

ALEX D. BAILEY
CHAIRMAN, ADVISORY BOARD ON STANDARDS AND CODES

Philadelphia Electric Co., to serve on the Committee for the customary five-year term, and that of Harley A. Johnson, general manager, Chicago Rapid Transit Co., to replace Charles T. Ripley, who found it necessary to resign. Vincent M. Zaffarano, assistant testing engineer, United Electric Light and Power Co., New York, N. Y., acted as junior adviser to the committee at its meeting on Monday when problems of administration and policy growing out of the Society's research activities were ironed out in a seven-hour session.

The annual luncheon meeting of the Condenser Tube Committee brought out a large attendance to listen to Bert Houghton present his eighth progress report. A much better understanding of the causes of tube corrosion and the means for its reduction is rapidly developing as a result of these meetings.

Receipt of an additional grant of $1000 from the Engineering Foundation this year was announced by the Metal Cutting Committee. The money is to aid the committee in preparing for publication the first instalment of its proposed metal-cutting handbook.

It was announced that the Fluid Meters Committee will shortly submit for publication a revision of Part I of the Fluid Meters Report on Theory and Application. Ohio State University will publish the data on orifice coefficients for the measurement of air and water which have resulted from the experimental work of the joint A.G.A.-A.S.M.E. subcommittee.

F. P. Zimmerli reported to the Mechanical Springs Committee success in raising $2000 from industry for an experimental program at the University of Michigan for the correlation of spring-wire binding and torsion-fatigue data.

Great interest was shown in the progress reports submitted by Messrs. Partridge and Schroeder of the investigation on solubility of sodium sulphate in boiler-water salines as related to the prevention of embrittlement. This work is being conducted under the auspices of the Joint Boiler Feedwater Studies Committee.

Other special and joint research committees that held meetings during the week were those on effect of temperature on the properties of metals, strength of vessels under external pressure, lubrication, absorption of radiant heat in boiler furnaces, critical-pressure steam boilers, and sampling of pulverized coal in a moving gas stream.

NON-TECHNICAL EVENTS—COMMITTEES

One of the interesting and valuable features of the Annual Meeting from the point of view of those who attended from out of town was the opportunity that was provided through the generosity and courtesy of plants in the vicinity to make inspection trips. Excursions this year were under the supervision of a special committee of which Charles Peace was chairman.

Another annual feature of the meeting is the opportunity for reunions of graduates of engineering colleges. Brown, Cornell, Harvard, Newark College of Engineering, Rensselaer, and Worcester held reunions this year.

As usual, a program of special events was arranged by the Woman's Auxiliary for the entertainment of women attending the meeting. Mrs. Crosby Field was general chairman of the Annual Meeting Committees. The chairmen of these committees were as follows: Mrs. W. S. Huson, registration; Mrs. A. H. Morgan, excursions; Mrs. Leo Geenens, luncheon; Mrs. C. P. Bliss, Annual Dinner; Mrs. W. W. Macon, annual tea; Miss Bertie Haar, publicity; and Mrs. J. W. Roe, Presidents' Night. Mrs. A. D. Blake is president of the Woman's Auxiliary.

The Annual Meetings of the A.S.M.E. are under the supervision of the Society's Committee on Meetings and Program. The 1934 Committee consists of C. P. Bliss, chairman, R. I. Rees, Ely C. Hutchinson, Harvey N. Davis, and Clarke Freeman. C. W. Parsons acted as chairman of the Dinner Committee, Charles Peace as chairman of the Excursions Committee, W. F. Parish as chairman of Presidents' Night Committee, A. D. Blake as chairman of the Reception Committee, and Frank L. Eidmann as chairman of the Information Committee.

ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Combination Hydraulic and Heat Power Plants

IN A PREVIOUS publication (*Archiv für Wärmewirtschaft und Dampfkesselwesen*, Vol. 14, 1933, pp. 231 and following) the author advocated systematic cooperation between hydraulic and heat power plants. In the present article he describes an actual installation of that character. In this installation the heat plant cooperating with a hydraulic plant neither buys current nor sells an excess thereof. It provides power and heat for a textile plant whose machinery is provided with individual electric drives and also belt drive from a main shaft. Steam is also used for heating and process purposes. Fig. 1 is a diagrammatic layout of the installation.

The first stage, constructed in 1900, consisted of two horizontal twin Francis turbines *g*. These turbines delivered power either to the main driving shaft of the plant through a mechanical frictional coupling, or also by a mechanical coupling to direct-current motor generators and a charging machine for a power battery. This charging generator and battery were removed at a later date and replaced as shown in Fig. 1 by an alternating-current generator. The rest of the demand for power was then satisfied by superheated-steam compound engine *f*, which delivers its energy either by means of a mechanical coupling to the main shaft of a rope and belt drive, or to a separate direct-current motor generator. The original boiler plant was replaced by a new one shown in Fig. 1. The direct current is used for lighting, electrolysis, and for certain special electric drives. The steam required for heating and process purposes is taken after it passes through an oil separator from the compound steam engine, and this is also supplemented by a supply of throttled live steam.

In 1910 a superheated-steam, twin, single-crank, compound engine *e* was added to the existing compound engine to provide additional mechanical drive. It drives either an extended main shaft or a direct-connected motor generator. This motor generator is so arranged that it can either take current from the general system or deliver an excess of the power output of the steam engine to it.

About 1920, with further development of the plant and expansion of the enterprise, it was decided to provide individual electric drives for all new installations. To satisfy the increased demand for current the Diesel electric set *h* was installed, while another set was designated to act as an independent stand-by unit cooperating with the steam and hydraulic units. The exhaust gases of the Diesel engine, when in operation, are used to heat about 9000 cu m of air per hr to about 65 C for use in drying. At that stage the hydraulic and steam plants were interconnected mechanically, and electrically with each other and with the heat plant.

Later, in 1926, a thermotechnical connection was set up as a result of a further increase in the demand for current and steam, as well as the necessity for increasing the reserve capacity of the machinery.

At that time it was found that the boiler plant was of insufficient capacity and obsolete from the point of view of thermodynamics and operation. It was concluded that it was not worth while either to increase its capacity or to rebuild it. As a result it was decided to keep the old boilers as stand-by units and to install a modern boiler *a* with a higher operating pressure.

With the newly installed output of about 1700 kw a condensing bleeder turbine showed no advantages as compared with a pure condensing engine operating with a live-steam heating system.

Turbo set *d* was therefore installed as follows: A separate back-pressure unit, running at 6000 rpm, and a condensing unit, with arrangements for cutting out, running at 3000 rpm, both deliver their energy through a gear drive to a direct-current generator of 1700 kw capacity running at 600 rpm. The back-pressure unit is provided with separate piping intended to supply the demand for process steam. The other power units are supposed to provide the remainder of the output as and when required. In the summer, because of reduced demand for steam, the condensing unit may be cut out completely.

The flywheel alternator which took the place of the battery and charging machine is now used to transfer the excess energy of the hydraulic plant *g* into an electric steam boiler *b*. The steam generated therein is next taken to a Ruths accumulator, in turn utilized to supply sudden peak demands for heating and process steam. The air heater *k* is supplied by the exhaust gas from the two Diesel engines and provides hot air for drying. It is connected in parallel with a waste-heat steam boiler, so that either the air heater or the waste-heat steam boiler can be operated as desired. Because the amount of steam generated D is slight as compared with the amount of cooling water Q of a Diesel motor (approximately 0.35 kg per effective hp-hr, giving a ratio $D\,Q = 0.049$), the cooling water which leaves the motor with an average temperature of 50 C is not used as feedwater for the waste-heat steam generator. Instead, it is delivered into a simple concreted reservoir *l* for washing and bathing and in the winter is used to prevent the formation of ice in the hydraulic plant. Table 1 indicates the plant connections, other than electrical.

TABLE 1

Diesel engine	Air heater	Hot air
	Exhaust-gas steam generator	Heating steam
Back-pressure turbine		Heating steam
Hydraulic turbine	Alternator	Heating steam
Electric boiler	Ruths steam accumulator	Heating steam
Hydraulic turbine	Rope drives	Drive to the main shaft
Reciprocating steam engine	Rope drives	Drive to the main shaft

The method of operation on an ordi-

nary working day in winter and summer (working hours 7 to 12 and 13 to 16.30 = 8.5 hr) is summarized in Table 2. During the idle time (15.5 hr) the energy generated by the hydraulic plant is stored as steam and used during the working period to level out the supply for process steam. The comparatively small load for lighting and minor drives operating during the remainder of the day are satisfied by two motor generators working from the same shaft.

In winter about 100 per cent and in summer about 60 to 70 per cent of the output of the turbo set is used in the counter-pressure unit. By putting the Diesel engine into commission, it is possible to eliminate the condensing turbine in summer as well and operate entirely on the back pressure. (The bus-bar values are given in Table 2.) With the condensing unit giving an output of about 750 hp, the turbines can deliver up to 2500 hp. The output of the back-pressure unit alone is 1750 hp with a maximum throughput of steam of 15,750 kg per hr. The turbo set can handle in a satisfactory manner possible deviations from regular output.

The twin single-crank compound engine drives the main shaft summer and winter. If its output is not sufficient at the flywheel rope pulley, the motor generator steps in with its maximum capacity of 300 kw. It gives up its excess output to the plant net. The machine therefore can operate at full load all the time, the compound engine constituting its reserve. The power demand of the plant at the main-shaft drive varies on an average from 800 to 1600 hp.

The proper way of incorporating the Diesel engine into the power system is given in Table 2. In special cases it can be used to a greater or lesser degree for covering the load demands. The method of operation shown here is claimed to achieve the following results: Complete utilization of the available water power; more than usually complete back-pressure operation of the steam turbine; utilization of the cooling water and exhaust-gas heat of the engines; and a high reserve-power capacity. The author does not believe that it would be economical to throw out the reciprocating steam engine and replace it by condensing turbines

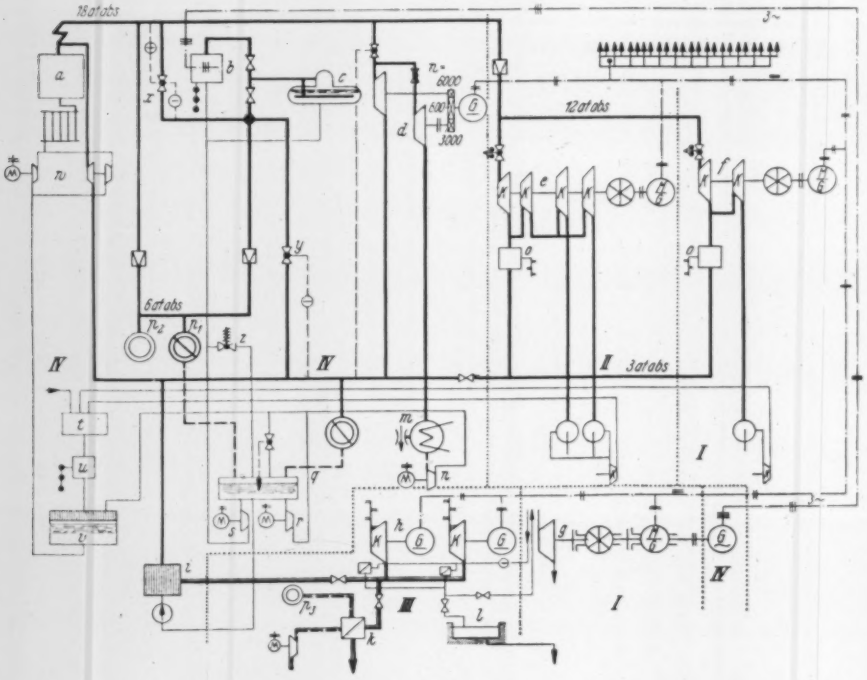


FIG. 1 DIAGRAMMATIC LAYOUT OF THE COMBINED HYDRAULIC-HEAT PLANT

a = Four sectional-chamber boilers, each with a capacity of 10 tons of steam per hr; at 18 atm abs and 375 C; grate area 14 sq m; total heating surface 375 sq m; superheater surface 135 sq m; heating surfaces in the economizer 275 sq m; preheating of feedwater from about 30 C to about 105 C.

b = Electric steam boiler for alternating current, 3150 volt, 50 cycle; maximum output 940 kg of steam per hr with a consumption of 750 kw; normal output 810 kg of steam per hr with a consumption of 650 kw.

c = Ruths steam storage for 14/4 atm abs, 120 cu m volume, storage capacity 9300 kg.

d = Drive turbine consisting of (1) a live-steam back-pressure unit for a maximum output of 1750 hp, (2) a unit which can be cut in or out and consisting of a live-steam condensing unit for a maximum output of 750 hp, giving a total of 2500 hp. Speeds in rpm, n_1 = 6000; n_2 = 3000; n_{Gen} = 600 (direct-current generator, 1700 kw). Condition of the steam head of the machine 17 atm abs, 350 C, back-pressure 3 atm abs.

e = Superheated-steam, twin, single-crank, compound steam engine with injection, condensation and provision for bleeding at 3 atm abs, N = 1200 effective hp, n = 150 rpm. Condition of steam ahead of the machine, 12 atm abs, 350 C; direct-current motor generator driven thereby, 300 kw at 250 rpm.

f = Horizontal superheated-steam compound engine with provision for bleeding at 3 atm abs N = 1000 effective hp, n = 150 rpm. Condition of steam ahead of the machine, 12 atm abs, 350 C. The machine drives a direct-current motor generator 300 kw, n = 250 rpm.

g = Two horizontal twin Francis turbines. N = 2 × 457.5 effective hp = 673 kw; n = 100 rpm.

h = Two compressorless 8-cylinder Diesel engines, vertical type, single-acting, four-stroke cycle, normal output 790 effective hp at n = 300 rpm, each direct-connected to a 500-kw direct-current generator.

i = One waste-heat steam generator for an operating pressure of 3.5 atm abs. The production of steam with one of the two Diesel engines running at full load is 290 kg per hr.

k = One air heater heated by exhaust gases. Heating air for drying purposes about 10,000 cu m per hr to about 60 C.

l = A washing and bathing tank for utilizing the cooling water from the Diesel engines for an exit temperature of about 50 C. This cooling water may be also led into the upper water channel of the hydraulic generating plant.

m = Surface condenser with water-jet suction.

n = Condensate pump.

o = Oil separator to be used in exceptional cases to purify the steam coming from the reciprocating engines.

p_1 = A device for utilizing heat with heating surfaces.

p_2 = A device similar to the above without heating surfaces.

p_3 = Drying apparatus which may be heated either by steam or by hot air.

q = Hotwell.

r = Return feed circulating pump.

s = Feed pumps for the electrical boiler and Ruths storage device.

t = Tank for the condensate from the injection condensers of the reciprocating steam engines and for raw make-up water.

u = Water-treatment plant.

v = Feedwater condenser with gas safety device.

w = Feedwater pumps.

x = Oil-operated overflow valve.

y = Oil-operated valve for controlling minimum pressure.

z = Electromagnetically controlled governor valve.

TABLE 2 REGULAR OPERATION ON WORKING DAYS OTHER THAN SATURDAY

Power generating machinery or steam storage	Winter: Stand-by hp	Winter: In operation, hp	Winter: Steam output kg per hr	Summer: Stand-by, hp	Summer: In operation, hp	Summer: Steam output kg per hr
Back-pressure turbine	..	1750	15750	..	1450	9920
Condensing turbine	750	..	...	..	750	...
Twin tandem steam engine	..	1200	...	..	1200	...
Compound steam engine	1000	..	...	1000	....	...
Diesel engine No. 1	..	790	290	790	....	...
Diesel engine No. 2	790	..	...	790	(790)	(290)
Hydraulic plant	..	732	...	..	940	...
Ruths accumulator	..	..	795	..	....	1025
Total	2540	4472	16835	2580	(4380) 4340	(11235) 10945
Coefficients, kg of steam per effective horsepower	..	3.76		..	2.52	
Reserve ratio	$\frac{2540}{4472} = 0.568$		...	$\frac{2580}{4340} = 0.594$		...

or Diesel engines. With the steam conditions ahead of the machines as they exist in this particular plant, there is a steam consumption of approximately 4.4 kg per effective hp-hr in the case of the reciprocating engine with injection condensation as compared with 4.2 kg per effective hp-hr in the case of a turbine with surface condensation. The author recognizes certain other advantages of turbine operation, but does not believe that they are sufficient to justify the expenditure that would be required to make the change.

The original article contains a brief description of the governor and control machinery, which is not reported here because of lack of space. (Hellmut Eickemeyer in *Archiv für Wärmewirtschaft und Dampfkesselwesen*, vol. 15, no. 7, July, 1934, pp. 173–175, 1 fig.)

SHORT ABSTRACTS

ELECTRICAL ENGINEERING

"Thyratron" Motor

THIS is a new motor of a type combining certain features of alternating- and direct-current motors and based on the use of a group of "thyratron" tubes acting as a rectifier or commutator. In this way a motor was developed operating at variable speed on a supply from a three-phase power system. A 400-hp motor of this type was built and is ready for commercial use. It belongs to the group of developments which are based upon the discovery that the starting of the anode current in a gas-arc rectifier could be controlled by a third electrode. Vapor electric devices such as grid-controlled gas-filled or mercury-vapor-filled electronic tubes, based upon this principle, are on the market under the trade name of "thyratron."

The thyratron set, which is an essential part of the motor equipment, has two distinct functions. One is grid-controlled rectification and the other is commutation. Each of these functions of the thyratron set has a significance in the practical application of the motor. Through the commutator functions, a motor is made available which operates on an alternating-current power supply but has smooth, variable-speed torque characteristics like a direct-current motor without any reference to synchronism with the alternating-current system. The grid-controlled-rectifier function gives a motor which has continuous power control from standstill to maximum speed. This power control has delicacy, quickness, and accuracy which is superior to anything heretofore available. It may be operated manually or with remote control, and lends itself well to automatic control for regulating speed and power for coordination with other machinery.

The theory of operation and features of this motor are presented in detail in the original article. (E. F. W. Alexanderson and A. H. Mittag, in *Electrical Engineering*, vol. 53, no. 11, November, 1934, pp. 1517–1523, 11 figs.)

New K. S. Permanent Magnet

THIS is a description of a strong magnetic steel having higher coercive force and higher magnetic induction than tungsten steel. This steel besides containing from 15 to 36 per cent of cobalt has also from 10 to 25 per cent of nickel and 8 to 25 per cent titanium. The best magnetic properties are attained by casting the alloy and annealing to about 660 deg. An addition of a small quantity of aluminum improves the magnetic property of the alloy. The residual magnetic induction and coercive force of the alloy depend upon the chemical composition of the material and grow with the increase of the intensity of the magnetizing field, as shown by examples in the original article. It is claimed that the new alloy is particularly suitable for short magnets. (Kotarô Honda, Hakar Masumoto, and Yuki Shirakawa, in *Science Reports of the Tohoku Imperial University*, First Series, vol. 23, no. 3, August, 1934, pp. 364–373, illustrated)

ENGINEERING MATERIALS

Behavior of Metals at Elevated Temperatures

THE article presents the work done by the Belgian Research Committee at the Laboratory of the Center for the Study of Steels installed in the University of Brussels.

The French Bureau Véritas defined the strength at elevated temperatures by two limits: (*a*) the "limit of elastic deformations without flow," and (*b*) the "limit of limited flow"—limits which, for purposes of calculation, may be likened to the elastic limit and the breaking stress determined in the cold state. The Belgian Research Committee found that these two limits appeared to merge into one another, and that their value was principally determined by the sensitivity of the measuring apparatus used. As a matter of fact, as soon as the creep became appreciable it was found to continue throughout, at a slowly variable rate, without any tendency to stop. The measurement of the "limit of elastic deformations without flow" has given rise to numerous controversies; the values given by the Véritas operators and by foreign operators often varied greatly.

In Belgium it was found for a number of steels that the successive increments of stress to which the test piece was subjected gave rise to very complex phenomena varying in importance according to the steel in question, and introducing into the measurement causes of error which were totally unacceptable. Another limiting creep stress put forward by French operators and defined as the stress per square millimeter, which, after being applied for four hours, produces no permanent deformation above 0.1 per cent of the length of the test piece, was investigated, and it was found that this limit falls but slightly with rising temperature, whereas all testing methods involving average or long periods show a very rapid drop in strength with rising temperature. The French method, therefore, gives a completely false idea of the

strength of the steel at high temperatures.

Exactly the same objection may be advanced against the measurement of conventional elastic limits in the hot state, a method of evaluation which was, for a time, advocated by German operators. Large deviations found in the results of the rapid four-hour French method, apparently so simple, directed the Committee's attention to the phenomena of "plastic retraction" and to the amount of the corresponding deformations. It was possible to resume the investigation of these phenomena in the autumn of 1933, and to elucidate their laws. What must be borne in mind in regard to them, in practise, is that this deformation is important—it goes up to and often exceeds a quarter of the plastic elongation which preceded it—and due regard must be paid to it in the tests, failing which, serious errors will be made.

This led to the investigation of the methods of medium duration advocated by German operators—measurement of the *Dauerstandfestigkeit*. This term designates a strength insuring a very long life to the test piece and determined by the rate of deformation which it imposes on the test piece during a reference period suitably chosen. This period of reference was first taken between the third and sixth test hours, then between the fifth and tenth, and finally between the twenty-fifth and thirty-fifth hours, the creep in each of these periods being uniformly 0.015 per cent of the length between the gage marks. According to the Kaiser Wilhelm Institut operators, the value of the Dauerstandfestigkeit is the same in three periods; this assumes that the deformation as a function of time takes place according to a definite and constant curve of geometrical form.

The Belgian Committee found from plotting curves under a constant load extending over periods from 50 to 100 hr that during the first hours of the test the flow phenomena are almost always irregular, but the irregularities usually disappear or become insignificant at the end of about 20 hr. When carbon steels or very low alloy steels were examined the Dauerstandfestigkeit appeared as a stress near which the rigidity of the steel at elevated temperatures underwent a rather sudden change. It would appear therefore that the Dauerstandfestigkeit could be regarded as a deferred breaking stress and could be introduced into structural calculations by applying a suitable factor of safety. The Belgian Committee is in disagreement with other views concerning Dauerstandfestigkeit and comes to the conclusion that for the steels investigated by the Committee, which included medium alloy steels, one of which was a chromium-copper steel, the measurement of the Dauerstandfestigkeit by German standards is a test not long enough to allow to judge safely the qualities of the steel. The same thing applies to Hatfield's "time yield." Only long-time tests (several hundred hours) are considered to be capable of furnishing safe data in regard to the practical value of steels to be used at high temperatures.

An interesting discussion on the properties of heat-treated steels is presented and cannot be abstracted because of lack of space. The apparatus used is described in detail. (Paper by Prof. H. Dustin, read before the Iron and Steel Institute, Brussels, Sept. 10, 1934, abstracted through abridged publication in *Engineering*, vol. 138, no. 3586, Oct. 5, 1934, pp. 367–368, 5 figs.)

Strong Die Castings

IT IS SAID that copper-alloy parts having the strength of steel and the corrosion resistance of an 81 per cent copper alloy can be now made as die castings with the smooth surfaces and dimensional accuracy characteristic of this method of production.

The material is an alloy marketed under the trade name of Brastil by the Doehler Die Casting Company. The physical properties of the material include a tensile strength of 85,000 to 90,000 lb per sq in. and a yield point of 60,000 to 70,000 lb per sq in. The composition of the alloy is not stated. Where the hardness of this copper die-casting alloy (160 to 180 Brinell with 3000 kg load) is not sufficient, steel inserts can be incorporated in the design. In such parts the contraction of the copper alloy is a distinct asset, because it helps to anchor the steel inserts. (*Product Engineering*, vol. 5, no. 9, Sept., 1934, pp. 336–337)

INTERNAL-COMBUSTION ENGINES

Guylin Charcoal Gas Producer for Gasoline Engines

THE producer here described is of the vertical-cylinder type with a steel-plate shell lined with fireclay 1 in. thick all around from the fire grate up to the water jacket. The water jacket is built inside of the producer and supplies steam for feeding the producer and for cooling a part of the outlet gas pipe in the cooling device. The producer is of a suction type, and the publication here referred to contains precise instructions for its operation. The unit has been developed in Canton, China, where the cost of gasoline is very high and where charcoal, even if not as efficient as gasoline, offers considerable attraction because of its low cost. (Chun C. Lee, Assoc-Mem. A.S.M.E., in English and Chinese, 43 pp.)

Converting Air-Injection to Airless Diesel Engines

AS COMPARED with air-injection Diesel engines the airless-injection type appears to be capable of giving a greater output by six per cent or more for the same fuel consumption. There is, therefore, a considerable attractiveness in the idea of conversion of the older type engines into the airless injection. It might be thought that this is a comparatively simple matter and means simply the replacement of the fuel injection pumps and valves by appropriate devices working on the airless-injection cycle. It appears, however, that more than mere replacement of parts is involved, primarily, because the combustion chamber of the air-injection engine does not have the proper shape to permit the stream of fuel projected into the combustion space by the air-injection pumps to develop properly without striking the cold cylinder or piston walls.

Moreover, conversion is considerably more difficult because the camshafts used in air-injection pumps are not strong enough to drive the fuel pumps in the airless-injection system with their suddenly developed maximum pressure of the order of 300 atm. The lift forces on these pumps are very much greater than those necessary to provide the drive in air-injection pumps.

In airless-injection engines the sudden action of the pump produces much higher stresses in all the driving parts of the pump system and requires greater forces to actuate the inlet, exhaust, starting, and fuel valves. Should it be attempted to run the fuel pumps for the airless-injection system from the camshafts installed for air injection, rapid wear of the driving parts will occur, with possible improper operation of the pumps because of distortion of the camshafts and at times breakage of the parts. Even were it possible to do so, the reenforcement of the camshaft drive or the installation of a special drive for the fuel-injection pumps would prove to be so expensive as to make the whole idea of conversion unattractive.

The Krupp Company in Germany claims that such a conversion can be effected in a practical manner and at a reasonable cost by using a scheme devised by Prof. Vadim Archaouloff and

further developed by the Krupp engineers. The basic idea of the Archaouloff scheme consists in utilizing the compression pressure in the engine cylinder to operate the airless fuel-injection pump. This brings about the advantage of the complete elimination of the mechanical drive of the fuel pump. It is merely necessary to provide a connection to the combustion chamber of the working cylinder and take from it the energy for driving the air cylinder of the injection pump. A pipe of comparatively small diameter provides the connection between the working cylinders and the air cylinder. Fig. 2 shows diagrammatically

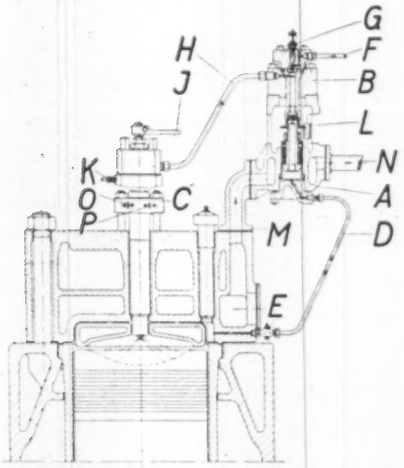


FIG. 2 SECTION THROUGH THE CYLINDER HEAD—ARCHAOULOFF-KRUPP DIESEL ENGINE

the Krupp arrangement of the Archaouloff device. *A* is the air cylinder of the injection pump; *B* the fuel-injection pump; *C* the fuel valve; *D* the pipe taking the gas from the combustion chamber to the injection pump, which may be shut off by means of cock *E* and cooled by locating a coil of the pipe in the cooling-water chamber of the cylinder cover. The fuel passes at *F* from the fuel pump into the injection pump and gets into the pressure chamber through valve *G*. Then it goes through the pressure pipe *H* to the fuel valve. In the illustration, *J* is a lever connected with the fuel valve in order to vary the tension in the valve spring. All the levers *J* of the engine are connected together and when necessary for starting a cold engine may be set into the desired position by means of a handwheel. *K* is the connection for a leakage pipe, which provides an outflow for the fuel, which during the running of the engine, runs in droplets along the valve needle. *L* is a scale showing the lift of the piston.

The cooling water from the cylinder cover used to cool the air cylinder of the injection pump comes in at *M* and leaves at *N*. *O* and *P* are the corresponding cooling-water connections for the fuel valve. The fuel enters the injection pump in a period of light pressure in the cylinder and, in converted air-injection engines, may be conveniently supplied under pressure by the already existing fuel pumps. This has the advantage that the valve rods as well as much of the piping need not be discarded. In new engines built on this principle the fuel can be led directly to the injection pump and regulated by the pump itself.

It may be thought that it is impossible to provide a sufficiently closely timed and uniform injection by means of an injection pump, the cycle of operations of which depends exclusively on the compression pressure in the engine cylinder. It must not be forgotten, however, that if the number of revolutions per unit of time has not been changed, the compression cycle remains practically unaltered. It would appear, therefore, that as long as the final pressure of the fuel-valve spring has not been changed, the injection must occur at the same crank position for all lifts, and practical tests have shown that this assumption is correct. Several indicator diagrams one after another show only immaterial deviations of the individual combustion curves, as is usually the case with other Diesel engines. A group of such indicator diagrams is shown in Fig. 3 in the original article.

In order to time correctly the combustion and the desired maximum ignition pressure, it is necessary to be able to displace the beginning of injection which in conventional fuel pumps is done by turning the nut on the camshaft. In the Archaouloff process this can be done in one of three ways as follows: Change in ratio between the diameters of the air piston and the fuel-pump plunger in the injection pump. This is difficult and requires the replacement of parts. The second way is to vary the end-compression pressure. This adjustment can be made only when the engine is not running and is recommended mainly in cases where, because of the wear of piston rings or packing, the compression pressure of the engine has fallen a material amount. The third way is to change the stress on the spring of the fuel valve. This can be done easily while the engine is running, and indicator diagrams reproduced in the original article (Fig. 4) show how such an adjustment affects the process of ignition. The diagrams show how a change in the adjustment of the valve spring produced a fall of ignition pressure from 51 to 43 atm. This method provides a convenient way of adjusting, on the basis of indicator diagrams, the ignition pressure of an engine to the desired amount while running.

Fig. 3 shows the Krupp construction of the injection pump claimed to be easily accessible and reliable in operation. The air cylinder has a replaceable bush made of special cast iron; the packing rings of the air piston are held in removable chambers in order to prevent distortion during the installation. The ring surfaces are provided with lubrication under pressure.

The original article illustrates two reconstructed designs of the fuel valve of such external dimensions as to make it possible for the valves to fit the existing cylinder covers of the engine. It is claimed that the combustion in the converted engines is excellent, notwithstanding the fact that the combustion chamber is not exactly suitable for the new method of operation.

It appears that the timing of the injec-

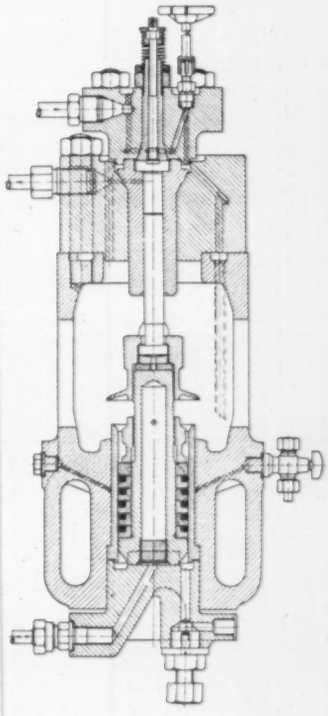


FIG. 3 SECTION THROUGH THE INJECTION PUMP—ARCHAOULOFF-KRUPP DIESEL ENGINE

tion used in the Archaouloff process is an important feature. As the injection pump is controlled by the pressure in the cylinder, the injection, after the first ignition has taken place, occurs with the rising pressure in the injection pump which continues up to the instant when the fuel plunger suddenly closes the ori-

fice leading to the pressure piping. Because of this the fuel is powerfully atomized up to the end and is emitted from the nozzle at a constantly increasing velocity, and therefore with finer atomization, and burns without after-formation of drops. In the original article the process of injection in the injection pump is shown by an indicator diagram.

Since the parts used in the Archaouloff method of conversion are simple and can be easily applied to any engine, the costs of conversion are said to be comparatively low. As an example are cited the six-cylinder engines of the tanker *Calgarolite* which have a maximum output of 2500 effective hp. Here the reconstruction cost, including all new parts and their installation, amounted to 6.50 marks per effective horsepower. If this is compared with the saving in fuel which is said to amount to 14 grams per effective horsepower-hour, at a price of 50 marks per ton, which means 4.20 marks per effective horsepower-hour per year of 250 days, it will be found that the conversion will pay for itself by the saving in fuel alone in $1^1/_2$ years. The conversion is justified economically, because of prevailing fuel-oil prices in Germany.

The estimate of a saving of 14 grams per effective horsepower-hour is equivalent to about 8 per cent of the consumption. More than twenty marine Diesel engines have been converted by the Archaouloff process at the Germania shipyards owned by the Krupp Company.

The Archaouloff process is said to be advisable for new engines because of the simplicity of the construction, the elimination of the camshaft, and the possibility of setting every fuel pump directly next to the fuel valve belonging to it. This makes the fuel pressure piping short and of equal length for all the cylinders, which, in turn, permits the same fuel-injection conditions for all the cylinders.

The Archaouloff process should be of particular interest in the case of large engines, especially those of the two-stroke cycle where the elimination of the camshaft as a means of driving the fuel pumps has a material effect on the entire design. (K. Mohr in *Technische Mitteilungen Krupp*, vol. 2, no. 4, September, 1934, pp. 85–92)

MACHINE PARTS

Horsepower Capacities of Helical and Herringbone Gears

IN THE method of computation presented by the author it is assumed that new gears are properly mounted when installed, reasonably well cut, and well lubricated. The author gives a formula which, however, does not include the pitch of the gears.

This is due to the fact that, within certain limits, the load operating capacity is not greatly influenced by pitch when the number of teeth in the pinion is kept between 16 and 30. As the velocity increases, the number of teeth in the pinion should increase, so that, as a guide, for pinions running under 500 fpm velocity, the number of teeth should be between 16 and 23; between 500 and 1000 fpm, from 17 to 27; between 1000 and 2000 fpm, the number of teeth should be from 19 to 30; and from 2000 fpm upward, there should be a minimum of 21 teeth in the pinion.

As regards material, it is assumed that it will have a tensile strength of about 100,000 to 110,000 lb per sq in. and a Brinell hardness of 250 to 270. A higher hardness may be encountered, however, in certain types of alloy steels. There are new special alloys with a surface hardness of 900 Brinell, but since little is known of these at the present time, it is not safe to include the general factor covering their use.

The formula is as follows:

$$\text{hp} = \frac{M_f F D^2 \times N \times S_f \times V_f}{1260}$$

where D is diameter of pin in inches; M_f the material factor; F the face of gear in inches; N the rpm of pinion; S_f the service factor; and V_f the velocity factor.

Three tables are given in the original article. The first is for the velocity factor V_f, which varies from 1.4 for less than 100 fpm to 0.7 for speeds in excess of 3500 fpm. The second table gives the service factor S_f for types of machines driven, and the third table gives the material factor M_f. These latter two are reproduced from the original in Fig. 4. (T. Holloway in *United Effort*, the United Engineering and Foundry Co., Pittsburgh, Pa., vol. 14, no. 9, September, 1934, pp. 3–4)

TYPE OF MACHINE DRIVEN	SERVICE FACTOR S_f
Hot and Cold Steel Continuous Strip Mills	45
Ferrous and Non-Ferrous Rolling Mills, Rubber Mills, Ball and Pebble Mills, Compressors, Heavy Fans, Cement Kilns, Suction Pumps and Cutter Heads, Speed Increasing Units	55
Duplex and Triplex Pumps, Steam Turbines, Power Shovels, Heavy Mixers, Hot and Cold Metal Forming Mills, Paper Mills	65
Large Hoists, Deep Well Pumps, Mixers, Agitators, Large Generators, Medium Fans	75
Medium Hoists, Heavy Conveyors, Light Fans, Centrifugal Pumps, Textile Machinery, Heavy Machine Tools	1 00
Light Hoists, Medium Machine Tools, Bending Rolls, Medium and Light Conveyors, Grain Elevators, Cranes	1 30

MATERIALS		MATERIAL FACTOR M_f
PINION	GEAR	
.4/.5% or .5/.6% Carbon Forged Steel	.35% Carbon Cast Steel Annealed	1
Alloy Steel. Pinion hardened to approximate 250 Brinell	.35% Carbon Cast Steel Annealed	1.3
Alloy Steel. Pinion hardened to approximate 250 Brinell	.5/.6% Carbon Cast Steel Annealed	1 5
Alloy Steel. Pinion hardened to 500 Brinell	Alloy Steel. Gear hardened to 500 Brinell	2.5

FIG. 4 VALUES OF SERVICE AND MATERIAL FACTORS

MACHINE-SHOP PRACTISE

Tools and Methods Used in Machining Fiber

HARDER tools, such as carboloy, high-speed steel, highly tempered saws, etc., should be used in machining fiber. In general, tools should be run at relatively high speeds taking heavy cuts and should be sharpened with little or no rake and ample clearance. Sheets of hard, vulcanized fiber up to $^1/_4$ in. in thickness can be cut into strips with power-operated drop-knife shears or with a power-operated rotary slitter. For rough cuts, band saws from $^1/_4$ in. to 2 in. in width are used and the saw should be run at approximately 4000 linear ft per min. The teeth should be ground straight across to insure straight cutting.

When smooth edges or accurate dimensions are required on tubing or sheets, a hollow-ground circular saw, 14 in. in diameter with 120 teeth, is recommended

for stock up to 1/4 in. thick. A saw with 80 teeth is recommended for stock over 1/4 in. thick. The saws should be run at approximately 3000 rpm. They should be hollow ground, 10-13-10 gage, and tempered hard. These saws should be sharpened every 30 to 50 min, without set, with very little front rake, and with a liberal amount of clearance, bringing each tooth to a sharp point

In most cases, holes with fairly smooth edges can be punched in hard vulcanized fiber up to 1/4 in. thick by rough-punching with dies similar to those used on metal.

When smooth edges are required, shaving dies are used on the rough-punched or sawed blocks. A cutting edge at an angle of 45 deg to the work shaves off from 1/16 to 1/8 in. of stock. As the die has no clearance for a distance of 1/4 in. back from its face, it can be ground without changing the size. Stock up to 1 1/4 in. thick can be smooth-punched and given a clean smooth edge by successive shaving operations.

Fiber parts can be machined on an ordinary lathe or screw machine from rod or tubular stock with a cutting speed of from 300 to 500 ft per min on carboloy or high-speed steel cutters. The coarsest feed producing the desired finish should be employed.

For drilling fiber, high-speed drills or special drills with a large spiral angle, narrow web, and wide flutes, such as are used for bakelite, are recommended. These drills should be ground with a liberal clearance and should be run at the highest practical speed.

In tapping these materials, the tap holes should be made from 0.003 to 0.006 in. larger than when tapping brass or steel. Allowance should be made for the fact that the drill cuts a hole a few thousandths of an inch smaller than the drill diameter. (*Machinery*, New York, vol. 40, no. 12, August, 1934, pp. 726–727)

MARINE ENGINEERING

The Melcher Propeller

THE particular feature of this propeller is a special sweeping of the generator guide line so that the concave side of the curve faces ahead, as shown in the right-hand diagram of Fig. 5. It is claimed that by the application of this curvature, all other characteristics being the same, it is possible to obtain improved results, such as increase of thrust and elimination of cavitation at the boss. The improved effect obtained with the new propeller is said to be caused by the fact that the water current on the outer part of the blades is pressed outward, which produces an additional underpressure as in the principle of a suction pipe. It is also said that the water current produced by the propeller maintains a flatter shape, which causes less disturbance in the stream flow.

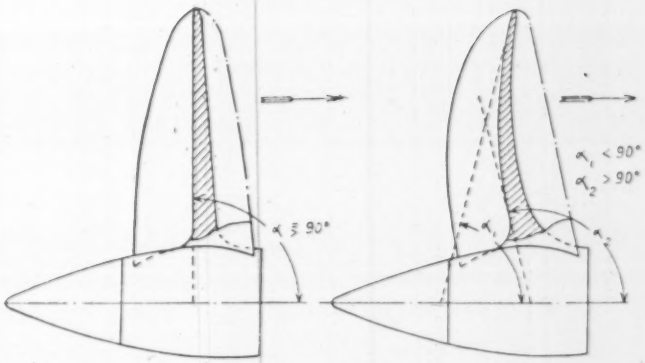


FIG. 5 NORMAL (LEFT) AND MELCHER (RIGHT) PROPELLERS

The original article gives, in the form of a diagram, results of comparative tests on tank models with "free-running" model propellers, that is, without a ship model. These curves would indicate a saving of about 7 per cent in horsepower by the Melcher propeller over the normal propeller, with a reduction in revolutions of about 4 per cent, the thrust being the same in each case. The propeller has been installed on the 750-hp twin-screw motor tug *Cosmos* and on several other vessels. It is claimed that this propeller is suitable for both high and low revolutions and speeds. (G. E. Bell, *The Shipbuilder and Marine Engine-Builder*, vol. 41, no. 295, September, 1934, pp. 460–461, 5 figs.)

MATHEMATICS

Bessel Functions

BESSEL functions find wide application in the solution of engineering problems, such as the vibration of strings, membranes, the flow of heat, etc. In fact, it is because of their application to one such problem, namely, the distribution of temperatures over the cross-section of a cooling cylinder, solved by Fourier in 1822, that Bessel functions are also called at times "cylindrical functions."

There are three kinds of Bessel functions. The most important are those of the first type usually designated by J. Here as a functional derivative of a variable x are obtained a group of functions, of the zero order $J_0(x)$, the first order $J_1(x)$, etc., up to the nth order $J_n(x)$. Orders of any value can be used producing such designations as $J_2(x)$, $J_{1/2}(x)$, etc. Functions of the second type are not used much, while the functions of the third type, also known as Hankel functions, are a combination of the first two types.

The most frequently used Bessel functions, $J_0(x)$ and $J_1(x)$, will be considered first. Referring to Figs. 6 and 7 it appears that the J_0-curve is similar to the cosine curve plotted as a broken line, while the J_1-curve is similar to the sine

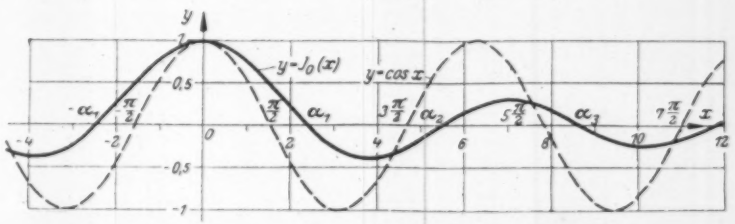


FIG. 6 FULL LINE IS THE BESSEL FUNCTION OF ZERO ORDER AND THE BROKEN LINE IS THE COSINE FUNCTION

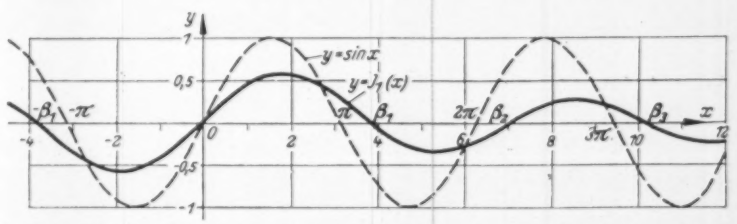


FIG. 7 FULL LINE IS THE BESSEL FUNCTION OF THE FIRST ORDER AND THE BROKEN LINE IS THE SINE FUNCTION

curve. There is a difference, however, in that the zero points, α of the J_0-curve and β of the J_1-curve, where the J-curves cross the x-axis so that $J = 0$, are not equally spaced as is the case with the zero points of cosine x and sine x (Table 1). Further, as x or $1/\sqrt{x}$ increases $J_0(x)$ and $J_1(x)$ fall off, while the waves of the cosine and sine curves always retain the same amplitude.

The importance of the Bessel functions $J_0(x)$ and $J_1(x)$ lies, for example, in the fact that by means of them the oscillations of such a body as a circular membrane can be represented with the same ease as the oscillations of a string are represented by the trigonometric functions cosine and sine.

If a stretched string, chain, or rope is so firmly attached at two points $z = -l$ and $z = +l$ on a z-axis (Fig. 8) that at the points where they are attached they can assume any direction whatsoever, and if the string oscillates freely, the amplitude of the fundamental oscillations can be represented by a cosine function. Moreover, the amplitude of oscillation v is described by the arc of the cosine curve, Fig. 6, $y = \cos x$ between the values of $x = -\pi/2$ and $x = +\pi/2$, providing it is extended or contracted in the x- and y-direction, as shown by the broken line of Fig. 8, giving the equation

$$v = V \cos \frac{\pi}{2} \frac{z}{l}$$

where V denotes the amplitude of oscillation in the middle $z = 0$, where the cosine is equal to unity. At the edges where $z = \pm l$, $\cos \frac{\pi}{2} \frac{z}{l} = \cos \left(\pm \frac{\pi}{2} \right) = 0$, as one would expect it to be.

In the course of an oscillation the departure from the maximum amplitude v decreases stepwise until all the points of the string pass simultaneously through a position of rest on the z-axis. The string then swings to the other side, up to $-v$ and then returns. The swinging consists therefore in a time-periodical increase and decrease of the departure from the median position between $+v$ and $-v$. The constant $\pi/2$ is here properly considered as the minimum zero position of the function $\cos x$, which disappears for the first time for $x = \pi/2$, Fig. 6.

The simplest case is that of derivation of value of v for $l = \pi/2$ and $V = 1$, in which case $v = \cos z$. Next, the amplitude of oscillation, that is, the upper limit line of the region traveled over by the string, is given by experiment. This gives directly the arc of the cosine curve of Fig. 6, $y = \cos x$ between the values of $x = -\pi/2$ and $x = +\pi/2$.

Next is considered not the case of a string but the motion of an oscillating circular membrane made of rubber, for example, attached along the edges of a circle of diameter 2 R and stretched over its circular area.

When oscillating fundamentally it arches itself to its maximum rise and forms a curved surface symmetrical on all sides.

The developed curve of Fig. 8 shows

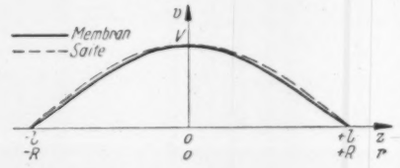


FIG. 8 DEVELOPED CURVES OF OSCILLATIONS REPRESENTING THE BASIC OSCILLATIONS OF A CIRCULAR MEMBRANE (FULL LINE) AND A STRING (BROKEN LINE)

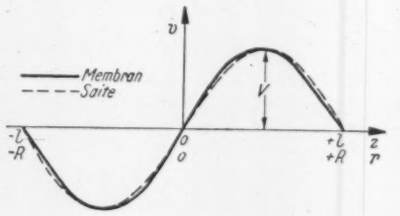


FIG. 9 CURVES OF OSCILLATIONS FOR THE FIRST UPPER SWING OF A CIRCULAR MEMBRANE (FULL LINE) AND A STRING (BROKEN LINE)

the parameter line along any diametral section v as a function of the distance from the center point r. This is expressed in the following manner by means of the Bessel function J_0:

$$v = VJ_0(\alpha_1 r/R)$$

Here V designates the knoll height of the membrane and $\alpha_1 \approx 2.40$ is the minimum zero value of the Bessel function $J_0(x)$. For $r = R$, v becomes 0 as it should be. The analogy with the string and the cosine function that expresses it is obvious, and it will be noted how little difference there is between the two curves in Fig. 8, one of which, in full line, denotes the case of a membrane, and the broken line, the case of the string. All that is necessary to pass from one function to another is to substitute R for l, r for z, α_1 for $\pi/2$, and J_0 for the cosine notation. The easiest to derive here is the amplitude of vibration v for $R = \alpha_1$ and $V = 1$, in which case $v = J_0(r)$.

When the string performs its first oscillation upward so that a "knot" in the middle of it remains stationary (Fig. 4, broken line) then it will be found that the amplitude of oscillation

$$v = V \sin \pi x/l$$

is merely a somewhat modified full wave of the sine curve. In order to produce a corresponding oscillation in a circular membrane, it is necessary to hold an entire diameter at rest, as a "knot" line.

Taken at right angles to it the amplitude of oscillations gives the developed curve of Fig. 9. This may be expressed by means of

$$v = WJ_1(\beta_1 r/R)$$

where J_1 is the Bessel function of the first order and $\beta_1 \approx 3.83$ is the minimum zero value thereof. In order to attain the same height as in the case of a string, a different constant W may be used, because, according to Fig. 6, J_1 never reaches the value of unity as does the sine.

The second, fourth, etc., upward oscillations of the string with 2, 4, etc., "knots" again bring us to cosine functions only with $3\pi/2$, $5\pi/2$, etc., instead of $\pi/2$. The corresponding oscillations for a membrane occur without the presence of a "knot" diameter, but with 1, 2, etc., "knot circles." Mathematically these may be described by J_0 and the nearest zero values of α_2, α_3, etc., substituted for α_1.

The author proceeds next to the discussion of the representation of Bessel functions by infinite series. This brings him to the conclusion that the J_0- and J_1-curves have essentially the same appearance as the cosine and sine curves, as was already established in Figs. 6 and 7. In the proximity of $x = 0$, the J_0-curve has joined to it a parabola $y = 1 - x^2/4$. As this parabola is wider than the parabola $y = 1 - x^2/2$ in the cosine curves, it is obvious that the J_0-curve intersects the x-axis later than the cosine curve. Actually the first zero value $\alpha_1 \approx 2.40$ of $J_0(x)$ is larger than the first zero value $\pi/2 \approx 1.58$ of $\cos x$ (Table 3). [Atten-

TABLE 3 ZERO POINTS FOR THE BESSEL-TRIGONOMETRIC FUNCTIONS

$J_0(x)$	$\cos x$	$J_1(x)$	$\sin x$
$\alpha_1 \approx 2.40$	$\frac{\pi}{2} \approx 1.57$	$\beta_1 \approx 3.83$	$\pi \approx 3.14$
$\alpha_2 \approx 5.52$	$3\frac{\pi}{2} \approx 4.71$	$\beta_2 \approx 7.02$	$2\pi \approx 6.28$
$\alpha_3 \approx 8.65$	$5\frac{\pi}{2} \approx 7.85$	$\beta_3 \approx 10.17$	$3\pi \approx 9.42$

tion is called to the fact that the value of $\cos x$ in Table 3 corresponding to $\alpha_1 \approx$

2.40 is not 1.58 as stated here, but 1.57.—Editor.]

What is called the differential equation of the Bessel functions is briefly referred to in the original article, from which the author proceeds to a likewise brief discussion of the differentiation of the Bessel functions.

Some of the applications of Bessel functions to such problems as those of heat conduction have been referred to before. Bessel functions for purely imaginary or complex variables are of importance for calculating the oscillations of circular plates and are of still greater importance in electrical engineering. (Prof. A. Walther, *Zeitschrift des Vereines deutscher Ingenieure*, vol. 78, no. 44, Nov. 3, 1934, pp. 1297–1299, 4 figs.)

MOTOR-CAR ENGINEERING

Self-Shifting Gear Transmissions

THE publication abstracted here deals with the principles of automatic transmission and not with descriptions of the well-known transmissions. After an introductory analysis it covers the subject of the choice of the highest and lowest gear ratios. In this connection the author considers the effect of wind on the operation of the car and says that the wind never helps until it blows from a quarter approximately 130 deg left or right of the car. The "head-on" or longitudinal component of the wind resistance is much greater when the wind is blowing from the side; roughly the quarter which makes the greatest demand on the engine is about 40 deg either side of the direction of the car's motion. It is more important to pay attention to reduction of air resistance for a relative wind 15 to 20 deg off "head on" than for the "head on" direction. A car streamlined only for head-on resistance but presenting a high resistance when inclined to the wind gains little or nothing by adopting such so-called streamline efforts.

The conclusion to which the author comes is that the streamlined car will require a greater range of gear ratios than the other type—at least four.

With the present hand shifting of gears this does not present a very attractive prospect so that one is led to the natural conclusion that streamlined cars give the most satisfactory performance with automatic transmissions, and these should be able to change a large number of gears more deftly.

The author next considers driving situations and the effect of reduced throttle. Of these the most important is the throttle condition in direct gear at low or moderate speeds.

The various controls and arrangements of transmission are next discussed, including governors in general and special types of governors. This part cannot be abstracted because of lack of space. It includes a detailed discussion of link, cam, and orifice governors. The cam governor may be made with a straight-line characteristic or otherwise. The effect of size on geometrically similar centrifugal governors and orifice governors are briefly discussed. (Dissertation submitted to the University of Michigan, by C. H. Powell, 1934, 66 pp. and numerous illustrations.)

Wood-Coal Producer Gas as Fuel for Motor Vehicles

AN INVESTIGATION made at the Institute of Agricultural Machinery of the Technical High School in Munich has shown that with air-dried wood in pieces of proper size and an apparatus properly supervised excellent results can be obtained from the use of gas producers on motor vehicles. The particular interest in the matter in Germany is due to the fact that the use of wood would make it possible to replace imported gasoline by a domestic product, in addition to which it is claimed that the cost of operation would be actually less.

In the gasification of wood there are produced several materials undesirable in the operation of a motor vehicle, such as tar, wood vinegar, and water vapor. These are partly segregated in the producer and eliminated. In particular, the tar and vinegar vapors entering the producer are sucked through a fire zone and are made innocuous. Materials consisting primarily of water vapor are carried off with the gas and are taken care of in the process of cleaning the gas.

An effort was also made to gasify fuels which are inherently free of the undesirable by-products of gasification and therefore do not require particularly careful attendance. To this category belongs wood-coal, obtained in the retorts in large amounts in the manufacture of acetic acid. This material is particularly suitable for making producer gas as it contains only a slight amount of water, is particularly free from tar, and comes in small lumps.

Table 4 gives the important physical properties of wood, wood-coal, and the producer gases obtained from both of them. The figures quoted are average values from a large number of determinations.

The gas producer built in Germany from Swedish designs is shown in Fig. 10. This gas producer operates on the principle of inverse combustion. The air

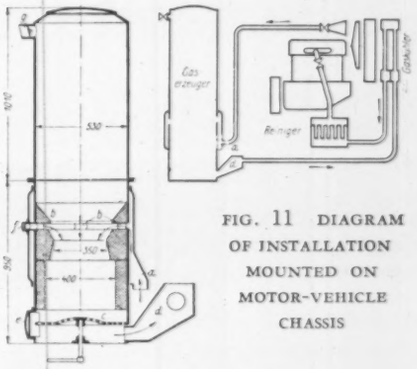


FIG. 11 DIAGRAM OF INSTALLATION MOUNTED ON MOTOR-VEHICLE CHASSIS

FIG. 10 WOOD-COAL GAS PRODUCER FOR MOTOR VEHICLES

for gasification enters at *a* and, after being preheated, passes through orifices *b* into the combustion chamber. The lower part of the gas producer is lined with highly refractory material. The gas flows through a shaking grate *c* and leaves the gas producer by way of a wide gas collector *d*, in which the gas velocity is reduced and a rough cleaning of the outflowing gas is obtained. The ashes can be removed at *e*. Fig. 11 shows diagrammatically how the whole installation can be mounted on a motor-vehicle chassis. The wood-coal is ignited through the ignition hole *f*. The gases of combustion escape into the open air through an elbow *g*, set in the upper part of the unit and provided with a closing device. The pressure prevailing in the gas producer even while the motor takes gas from it can be used to remove the water vapor originating in the combustion of wet wood-coal, thus preventing the undesirable fall of temperature

TABLE 4 IMPORTANT PROPERTIES OF WOOD, WOOD COAL, WOOD GAS, AND WOOD-COAL GAS

	Solid Fuel			Gas						
	Water content, per cent	Heat value, kcal per kg	Weight, kg per cu m	Composition, per cent CO	H_2	CH_4	CO_2	N_2	Lower heating value, kcal per cu m
Soft and hard wood air dried.....	10 to 25	3200 to 3500	240 to 340	21.7	18.5	1.8	11.0	47	1290
Beech, wood-coal..	<5	about 7100	210	31.9	5.6	2.6	2.3	57.6	1340

in the reduction zone. Upon leaving the gas collector *d*, the hot gas is cooled by the stream from the fan in a gas cooler set ahead of the engine radiator.

For removing ash and soot from the gas a box-shaped cleaner 480 mm long and having fabric filter pockets is provided. The gas is not expected to contain water vapor as this would produce mud on the filter elements. It is because of this that the blowing off of the steam through the elbow *g* is important. From the cleaner the gas goes to the air-mixing chamber and then to the engine. The weight of the total installation for an engine output of 80 hp is about 400 kg. The tests were carried on a motor with the compression ratio of 6.89 to 1.

It requires about 45 min to start the plant, the engine being started on benzol and used for blowing the gas producer. It was possible, however, to reduce the starting time to about 10 min by providing a circulation pump in the motor suction line. Curves in the original article provide information as to the output at engine speeds from 735 to 1300 rpm as well as the hourly and specific wood-coal consumption. It was found that the specific fuel consumption was about 0.45 kg per hp-hr with a normal speed of 1100 rpm. The temperature of the atmospheric air was about 25 C and the temperature of the gas previous to mixing with the air of combustion was from 38 to 42 C. An analysis of the gases for the range from 735 to 1700 rpm is given in a table in the original article. No clear relationship between the composition of the gas and the hourly throughput of fuel could be established. The heating values are, however, considered to be good.

The filter operated in a satisfactory manner during the entire period of test. The cleaning of the gas is good and the work of maintenance small as long as moisture does not get into the filter. Particularly deserving of attention are the results of tests in which water vapor was injected into the gas producer. After preliminary tests the producer was equipped with an evaporator heated by fresh gas with a temperature of about 570 C and a normal speed of operation of 1100 rpm. This arrangement permitted injection into the producer of measured amounts of water vapor. This permitted control of the excessive heating and reduction of the temperature of gasification which was helpful to the protection of the interior parts of the gas producer, particularly the brickwork. Furthermore, formation of H_2 was promoted and the ignitability of the gas improved. With this arrangement and a normal engine speed of 1100 rpm, the output was increased by 4.5 per cent and the hourly consumption of fuel was reduced 7 per cent.

Tests were undertaken on the recovery of the engine exhaust gases considered to have an important practical and economic significance. By reintroducing part of the exhaust gases from the experimental motor into the gas producer and by reducing the amounts of carbon dioxide brought about thereby, the fuel consumption at full load and normal speed of the engine was reduced by about 17.5 per cent, while the engine output has fallen off by only 5.9 per cent.

From these experiments it would appear that notwithstanding its higher price per unit of weight, wood-coal should be considered as a source of fuel for the operation of motor vehicles side by side with wood. This is particularly so as good wood-coal is practically free of tar and acetic acid, both of which act unfavorably on the operation of a motor vehicle. (Prof. G. Kühne, *Zeitschrift des Vereines deutscher Ingenieure*, vol 78, no. 43, Oct. 27, 1934, pp. 1241–1242, 2 figs.)

POWER-PLANT ENGINEERING

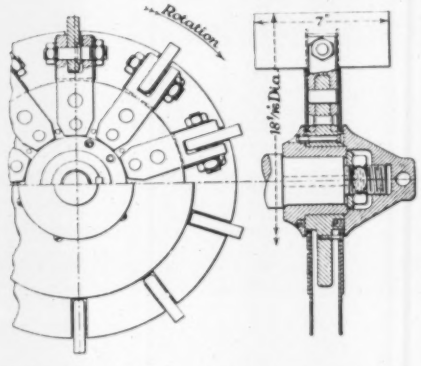
Buell Pulvex Coal-Pulverizing Mill

THIS mill is built in England. The pulverizing chamber is roughly rectangular in form. In the wear zone it is lined with chilled cast-iron plates. The fixings of these plates are so designed that they are not affected by the abrasive action of the powdered coal and the plates can be easily removed when worn. The liners are of simple form so that in emergency they could be temporarily replaced by plain iron castings obtained from a local foundry.

The rotor is so arranged that the coal entering at the bottom of the pulverizing chamber is picked up by the rotor blades, carried around the rotor casing, and projected into the vertical trunk, being broken up by violent contact with the walls. Any iron delivered to the pulverizing chamber with the coal is thrown off tangentially and retained in a special pocket fitted with a door through which the metal may be cleared at intervals.

Some interesting features have been introduced into the design of the rotor for the purpose of preventing the wear of the bolts securing the beaters. Referring to Fig. 13, it will be seen that the rotor disk, which is of 40-ton carbon steel, is secured to a hub, keyed on to the shaft, by means of shearing pins, and is locked in position by a large conical nut, the thread of which is such that it is self-locking during rotation. To carry the beaters, of which there are ten in the machine illustrated, slotted forks are fitted over the disk, each fork being secured by a ground and fitted pin and a countersunk rivet. The beaters are in the form of rectangular plates of nickel-chrome steel, heat-treated to give a tensile strength of 100 tons per sq in., and fit into slots formed in the ends of the forks in a direction parallel with the axis of the rotor shaft.

Each beater plate is drilled with a recessed hole and a special bolt of nickel-chrome steel, heat-treated to give a tensile strength of 65 tons to 70 tons per sq in., passes through this hole and two corresponding holes in the end of the fork, as will be clear from Fig. 12. It should be noted that the part of the shank of the bolt on the right in Fig. 12 is of larger diameter than that on the left, the



FIGS. 12 AND 13 ROTOR DISK ARRANGEMENT IN THE BUELL PULVEX COAL-PULVERIZING MILL

two diameters being joined by a conical portion, on which is fitted a loose washer with a correspondingly coned hole. This washer fits into the recess formed in the beater plate, thus giving a good bearing on the latter and holding it securely when the left-hand nut is tightened. Additional security is, of course, provided by the right-hand nut, and both are fitted with lock plates to prevent their slacking back.

To protect the nuts from abrasion, steel shrouding plates are screwed on to the hub on each side, one pair extending beyond the outer ends of the forks holding the beaters, and the other pair terminating just clear of the inner edges. Owing to the symmetry of the rotor in the plane of rotation, it is possible to equalize the wear on the beater plates by reversing the position of the rotor on the shaft. Generally, a spare rotor would be kept, and this could be placed in position by one man in 10 min.

The mill illustrated is driven by a 25-hp

motor running at 3000 rpm. Its capacity is from 440 to 2240 lb per hr, crushed so that 80 per cent passes through a 200-mesh B.S. sieve, with not more than 5 per cent residue on a 100-mesh B.S. sieve. Two smaller and one larger size mills are made, the latter being driven by a 40-hp motor running at 1500 rpm and having a capacity ranging from 1760 to 3360 lb per hr to the fineness specified. The two smaller mills are driven by 7-hp and 11-hp motors, respectively, both running at 3000 rpm, and the capacities are 50 to 370 lb per hr, and 220 to 740 lb per hr. (*Engineering*, vol. 138, no. 3588, Oct. 19, 1934, pp. 410–412 and 414, 9 figs.)

PUMPS

High-Vacuum Rotary Pumps

INCREASING demands for unusually high vacuum in commercial operations have been met in recent years by the use of oil-sealed rotary-plunger type vacuum pumps. Many installations now are operating at an absolute pressure of a fraction of a millimeter, and some pumps, notably in the electric-lamp and radio-tube industries, are producing pressures of a few microns. This made it necessary to obtain more convenient tables and charts covering data useful under high-vacuum conditions, and the original article gives a temperature and volume chart based on the standard steam tables and showing the temperature at which water evaporates or condenses at various degrees of vacuum. The choice of oil for sealing the vacuum pump is very important under high-vacuum conditions. The thorough removal of condensed water droplets from oil has been accomplished by the use of a small centrifugal clarifier through which all oil leaving the exhaust ports is passed before being returned to the oil reservoir. In the electrical field a drying process is now being performed at 300 microns, finishing at 100 microns, in a 22-hr period, using one of these rotary oil-sealed pumps equipped with a clarifier (from 30 to 40 hr were formerly required).

The efficiency of the rotary oil-sealed pump will average around 80 per cent up to about 29 in vacuum, dropping rapidly from 29½ in. The length and diameter of pipe lines have a very marked effect on the performance of high vacuum. High-vacuum calculations are given in the original article. (Lawrence H. Bailey, Chemical Engr., F. J. Stokes Machine Co., Philadelphia, Pa., in *Chemical and Metallurgical Engineering*, vol. 41, no. 7, July, 1934, pp. 358–359, 3 figs.)

TEXTILE ENGINEERING

Casablancas' Compound Drafting Machine

IN VIEW of the success of the high drafting in cotton spinning, efforts have been made to extend further the application of its principle, which led to the development of a new principle named compound drafting. It was worked out by Casablancas some years ago and the first machines of that description were made in Germany by Richard Hartmann, of Chemnitz.

Casablancas' compound drafting consists in subjecting the fibers to two consecutive drawing mechanisms during their passage through the machine. In between these two mechanisms a special device is introduced to keep the fibers gathered together.

One of the features of the machine is that the huge total draft is arrived at by the combination or compounding of quite moderate drafts at each point. The speed at which the first drafting works is said to be exceptionally slow which is important as the slower the operation of drafting is performed the better the result will be. The apparatus is described in detail and it is said that for normal work, drafts of 50 to 400 may be used, the main factors governing the amount of draft to be performed being the maximum weight of regular silver or coarse slubbing which can be successfully produced from the available preparation machinery. The most suitable drafts for various cottons are given in the original article. The main advantage of the process is said to lie in the complete suppression of three or four processes of speed frame.

The matter of roller weighting is discussed in the original article as well as the mechanism for inserting the false twist. (*The Textile Manufacturer*, vol. 60, no. 718, October, 1934, pp. 413 and 417, 3 figs.)

THERMODYNAMICS

Drop Condensation and Heat Transfer

THE author reports on recent experimental work in the United States and the Dutch Colonies. Only the latter will be abstracted here and deals with the work of Spoelstra at a Javanese sugar refinery. The impetus to undertake this research was given by the observation that pipes after being cleaned with naphtha, as is commonly done there, showed a heat transfer 25 to 30 per cent worse than before cleaning.

Analysis has shown that the original deposit on the pipes contained from 15 to 30 per cent of an oily material and that this is removed by the naphtha. Repeated experiments confirmed this observation and showed further that when at the start a deposit was present on the pipes fairly free from oil but the pipes were slightly corroded, the heat transfer was improved by cleaning to the extent of 25 to 60 per cent. Polishing clean pipes also produced an improvement in heat transfer. The heat transfer was also improved by an injection of some oil in the steam in the case of smooth clean pipes, as well as pipes having a light oilless deposit.

The tests made by Spoelstra were completed before the publication of an investigation dealing with the same subject by E. Schmidt and his associates (*Technische Mechanik und Thermodynamik*, vol. 1, 1930, p. 53 and following.)

Spoelstra initially attempted to explain what happened by ascribing the difference in heat transfer to a more rapid flow of the condensate over an oily surface or through the rupture of the water film. After the Schmidt publication appeared he undertook a new series of tests with the simple arrangement shown in Fig. 14. The following data, among others, have been obtained. With clean copper or brass tubes the method of condensation is not easy to predict. In the case of raw, scratched, degalvanized, and otherwise injured tubes, film condensation should be expected, while drop condensation takes place on smooth well-polished surfaces. The roughness of the surface necessary to produce film condensation need not be such as to be visible to the naked eye. By fine lapping of a smooth surface film condensation may be obtained and this may be converted to drop condensation by the addition of a small amount of oil. Oil-free deposits lead to film condensation even when the deposit seems to be perfectly smooth. An addition of oil produces frequently complete or partial drop condensation which does not occur with the original rough deposit. The finest droplets form on very smooth oil surfaces. Similar results have been obtained with

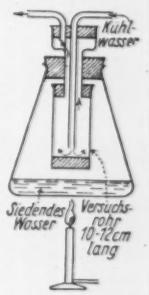


FIG. 14 EXPERIMENTAL INSTALLATION FOR TESTING HEAT TRANSFER IN TUBES (*Kühlwasser* = cooling water; *Siedendes Wasser* = boiling water; *Versuchsrohr 10–12 cm lang* = test pipe, 10 to 12 cm long.)

tubes 1 m long. The important practical conclusion from this work is that a thin oil deposit improves rather than reduces heat transfer. (Prof. M. Jakob in *Chemische Apparatur*, vol. 21, no. 6, Mar. 25, 1934, pp. 53–55, 5 figs.)

Specific Heat of Water at Temperatures From 0 to 350 C and at Saturation Pressures Up to 260 Kg per Sq Cm

IN ORDER to obtain fundamental values for steam tables, tests were carried out at the Laboratory for Technical Physics of the Technical High School in Munich to determine the specific heat of water, the same apparatus having been used as that employed for the determination of the specific heats of superheated steam. (*Forschungsarbeiten*, W. Koch, Vol. 3, 1932, p. 191.) The distilled water used in the test was carefully boiled under vacuum to eliminate the gases held therein and was not permitted to come in contact with atmospheric air. It was then forced into the experimental installation by a high-pressure reciprocating pump over a vessel provided with automatic pressure regulation. It had been previously established by the same author that the amount of air taken up in such an installation by diffusion was extremely small. During the pauses in the experimental work the vessel was kept under vacuum.

The water was brought to the desired temperature in three tube heaters and then led to a heat-insulated calorimeter in which a measured amount of heat was supplied to it electrically. The inlet and outlet temperatures of the water after a permanent state has been reached were measured by resistance thermometers. A scale was used to measure the pressures.

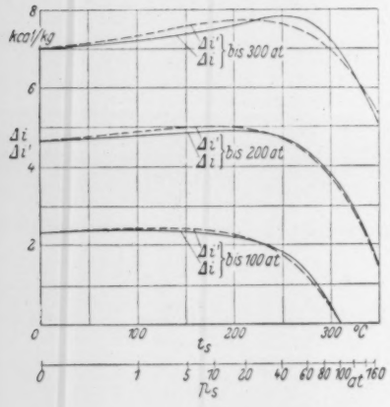


FIG. 15 HEAT EXPENDITURE IN ISENTROPIC AND ISOCHORE COMPRESSION, THE FORMER BEING ADIABATIC AND THE LATTER AT CONSTANT VOLUME, AS FUNCTIONS OF THE SATURATION TEMPERATURE AND PRESSURE

(*bis* = up to.)

At the end the water was cooled down in a condenser, passed through a regulating valve and weighed at predetermined time intervals. The specific heat c_p could be measured from the amount of heat supplied to the calorimeter, the rise of temperature produced thereby, and the amounts of water passing through per unit of time. Some consideration should be given to the slight temperature variation occurring because of the inevitable throttling in the calorimeter. This has been determined by a separate series of tests in which the heating of the calorimeter was cut off. On the basis of the results of these tests the following equations have been set up for determining the value of c_p. For temperatures from 0 to 140 C:

$$c_p = 1.006 - 10^{-3}\,t - 2.56t^{1.3} - 3.5 \times 10^{-7}(t + 114.3)p$$

From 140 to 280 C

$$c_p = 0.89 + 5.04 \times 10^{-10}T^2(1516 - p) + 6.27 \times 10^{-42}(100 - p^{0.675})$$

From 280 to 350 C

$$c_p = 8.577 \times 10^{-8}T^{1.25}(5343.4 - p) + 10^{-99.849 - 0.00494p}T^{36}$$

In these equations t is the temperature in deg C, T the temperature in deg abs, and p the pressure in kg per sq cm. In Table 5 are collected some of the values of c_p in kcal per kg per C calculated from the equations.

From the calculated values for the heat content i and entropy s, the i-s diagram of Fig. 16 has been plotted. From it the variations in the state of the liquid may be read in the usual manner. Some of the notable variations in state have been investigated. It was found, among other things, that the expenditure of work Δi in an isentropic compression shows no material difference between expenditure of heat Δi in a compression process in which the specific volume is considered as invariable. In Fig. 15 are given the calculated values of $\Delta i'$ as well as Δi, the latter being taken from the i-s diagram, and extending over saturation temperature and saturation pressure for a compression from the saturation pressure to 100, 200, and 300 atmospheres.

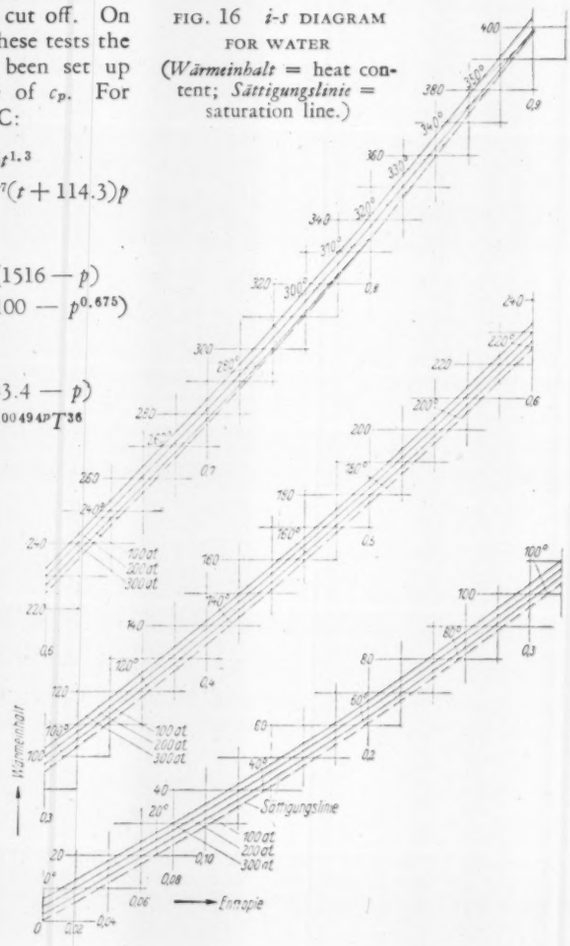
TABLE 5 COMPUTED SPECIFIC HEATS c_p OF WATER

t	c_p, kcal per kg per deg C		
C	100 atm	200 atm	300 atm
0	1.002	0.998	0.994
100	1.000	0.993	0.986
200	1.064	1.050	1.037
300	1.352	1.266	1.223
350	...	1.963	1.536

Consideration of the throttling process has shown that up to about 240 C the loss of pressure is explained by a rise in temperature. Between 240 and 250 C is a range in which the temperature does not change (the so-called "inversion"). At higher temperatures there is a fall in temperature. A comparison of the results obtained in this investigation with those of other investigations is said to indicate a very good agreement. The values for the heat content of water under saturation pressure in the international steam tables and various other steam tables agree with the results of these tests up to about 270 C, but are much larger for the higher temperatures. (W. Koch in *Zeitschrift des Vereines deutscher Ingenieure*, vol. 28, no. 38, Sept. 22, 1934, p. 1110, 2 figs.)

FIG. 16 i-s DIAGRAM FOR WATER

(*Wärmeinhalt* = heat content; *Sättigungslinie* = saturation line.)



LETTERS AND COMMENT

Brief Articles of Current Interest, Discussion of Papers, A.S.M.E. Activities

Economic Lot Sizes in Manufacturing

TO THE EDITOR:

Professor Norton in his discussion[1] at the A.S.M.E. Wood Industries Meeting, at Camden, N. J., Oct. 23–24, is to be congratulated upon stressing the application of the economic lot-size theory rather than developing complexities of minor variations of the theory. Since Prof. R. C. Davis' article,[2] an early one on the subject, the theory has had a great many expositions and variations. Prof. F. E. Raymond has made what is probably one of the most detailed analyses. Certainly the proposition, which is essentially the same as Kelvin's law for electrical power transmission, has been developed thoroughly enough by now to leave no doubt as to its accuracy and availability for a wide range of applications.

The main problem now is to make the theory useful, a ready tool for management. With that in mind Professor Norton has done a real service in demonstrating the flexibility of application, because one of the most forbidding aspects of this theory to "practical" men is that only one exact lot size is economical. The fact is there is a fairly wide lot-size range from which to choose without greatly increasing the minimum unit cost. W. L. Jones, of the Hawthorne Works of the Western Electric Company, who has been largely responsible for the work there on economic lot sizes, says in this regard, "From a large number of studies we determined that in general a 25 per cent variation either way from the true economic quantity has a very slight effect on the cost. This at once led us to drop from consideration a number of factors whose influence on the lot size was small and which were difficult or costly to determine."

Various devices are available for solving the economic lot-size equation quickly. An alignment chart designed for a woodworking plant is shown in Fig. 1 which can be operated by any one able to read a scale. Obviously its accuracy can be increased by limiting the range of values and increasing the scale length. A circular slide rule has been developed by W. L. Jones and E. F. Vacin, also of the Hawthorne Works of the Western Electric Company, where large savings were effected by the use of economic lot sizes.

TABLE 1

(I = 13 per cent expected rate of return on investment, taxes, etc.; A = 0; N = 216 working days per year)

Part No.	Operations	Unit cost C	Set-up cost S	Used per day U	Economic lot Q_e	No. per assembly	Corres. no. of assemblies in economic lot	Assuming 285* assemblies in lot Q	Unit value at Q_e	Unit value at Q
1	Cut off and rip....	0.0401	0.0640	166	940	9	104	2565	0.04024	0.04032
1	Mold and tenon...	0.0571	0.7130	166	2620	9	291	2565	0.05762	0.05763
2	Cut off and rip....	0.0526	0.0640	74	545	4	136	1140	0.05283	0.05290
3	Cut off and rip....	0.1752	0.0640	37	210	2	105	570	0.17581	0.17614
3	Mold.....	0.1846	0.3360	37	470	2	235	570	0.18603	0.18606
	Assembly.....	2.0836	2.680	19	285	1	285*	285	....	....

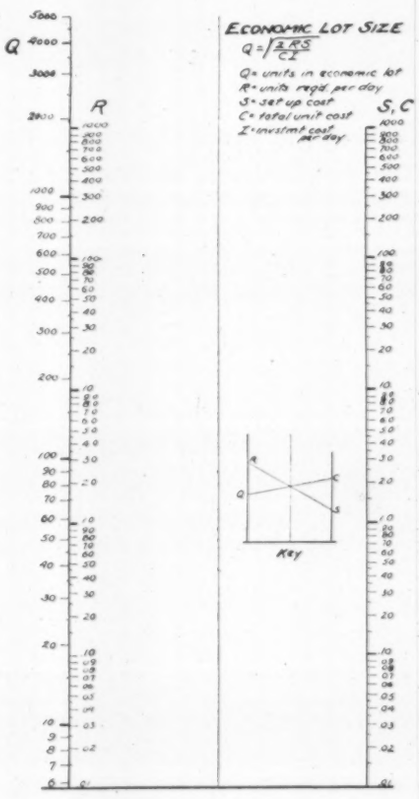


FIG. 1

There is a question concerning the application of economic lot-size formulas which is puzzling and which is not specifically answered in Professor Norton's paper. Assuming the usual case in which a final product is an assembly made of several parts, the question arises whether the formula should be applied to individual operations; for example, to cutting off, to ripping, to surfacing, to molding, etc., or to the combination of operations necessary to make one unit part, or one sub-assembly, or to all operations for one finished assembly. Table 1 is a specific example to which one of the recommended equations has been applied. Several different answers are obtained, depending upon the stage of manufacture.

R. H. McCARTHY.[3]

TO THE EDITOR:

Mr. McCarthy's discussion of the writer's recent paper will be of great assistance in proving to skeptical industrial managers that economic lot-size studies are worth while and practical.

In his last paragraph, he refers to a part of the problem which is indeed puzzling. In certain industries where there is no repair-part business and no interchangeability of parts, it is customary to produce just enough of each part for the desired number of complete articles, in which case it is probable that an economic lot-size study based on the combination of operations necessary for the complete article will give satisfactory results.

[1] See also MECHANICAL ENGINEERING, October, 1933, pp. 608–610.

[2] *Management and Administration*, April, 1925.

[3] Engineer, Development Organization. Western Electric Company, Maspeth Station, Long Island, New York. Assoc-Mem. A.S.M.E.

Where the several parts of the finished product are stored before going into assembly, either because these parts are sold separately or are used in a number of different assemblies, it would seem desirable to make separate studies of each part and to base the size of lot for each part on these separate studies. It is fortunate that the lot size may be varied a considerable amount either way from the true economic lot size without greatly affecting total unit charges. It will be noted that there is very little difference between the total unit charges shown by Mr. McCarthy for the two methods of determining lot sizes in his Table 1. Calculations similar to those indicated in Table 1 might well be made in cases where it is difficult to determine which method to use.

We still have available a few copies of our Bulletin No. 31 which goes further into this problem than was possible in the writer's paper. Any one desiring a copy of Bulletin No. 31 should communicate with the writer.

PAUL T. NORTON, JR.[4]

Dynamical Production Analysis

TO THE EDITOR:

Mr. Smith claims that his paper[5] presents a method of analysis which may be useful in predicting the probability of future production in any manufacturing industry.

By way of illustration, he attempts to determine the advisability of expanding the capitalization of the air-mail service by studying the growth of air mail. Is he not putting the cart before the horse? Can there be any mail service unless capital is first put into it? Can it grow unless its use of capital grows? It should be kept in mind that that portion of the initial capital which is not used to its maximum capacity is not active capital but reserve capital. Any increase in mail service not accompanied by the purchase of new capital will bring into use some of this reserve capital which from the service standpoint is new capital. Thus there can be no increase in mail service without increasing its active capital. In general, the birth of a service requiring capital is dependent on the initial capital put into use in that service and growth of a service is dependent on and can only follow growth of capital in use in that service. In other words, service growth follows capital growth which is the opposite of Mr. Smith's contention.

Mr. Smith's examples of the remarkable accuracy with which the future production might be predicted by his method may be used to indicate its fallacy. If in 1920 he had predicted the production of various commodities for a five-year period and industry had acted on this prediction by controlling capital expansions, the accuracy of his estimate would be materially lower. For without the overexpansion of capital which actually occurred, there would not have been the purchasing power that there was in the hands of those employed in the capital-goods industry. When you prevent overgrowth of capital, you decrease the demand for the use of existing capital and it soon follows that actual production falls. Thus under the present system if we should develop a reliable way of predicting the future production, any attempt to act upon this prediction would destroy its reliability. It would be accurate and reliable only if it were not used. The more we rely on it the less reliable it becomes!

It seems to me to be false logic to plan future capital growth on the basis of its past unplanned use. The moment you begin to plan and control, the demand which previously existed changes radically, and is no longer a reliable foundation upon which to build. The foundation of demand loses carrying capacity faster than the capital load decreases. Or if we increase the capital load, the foundation of demand does not increase its carrying capacity with sufficient rapidity. The solution of our economic problem cannot be found by increasing or decreasing capital but only in changing the relation between capital and demand.

Dynamical-production analysis of an unplanned and uncontrolled industry cannot furnish a rational basis for the planning of a controlled industry. The rational basis would be an analysis of our resources, capacity, and desires rather than a study of our unplanned and uncontrolled antics.

The logical thing to do is to forget the stupid past and to plan and control production and distribution to suit our desires and resources. Obviously, this cannot be done under rugged individualism nor with our present distribution of income on which demand depends. Nor can it be accomplished with our present great concentration of capital in private hands, for this means concentrated incomes without the requisite desire to translate them into demand. The problem must be solved as a whole and cannot be solved piece-meal.

ADOLPH MOSES.[6]

[4] Professor of Industrial Engineering, Virginia Polytechnic Institute, Blacksburg, Va. Mem. A.S.M.E.

[5] See MECHANICAL ENGINEERING for August, 1934, pp. 470–475.

[6] New York, N. Y.

A.S.M.E. BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information on application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval, after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Below are records of the interpretations of this Committee formulated at the meeting of October 19, 1934, and approved by the Council.

CASE NO. 776 (*Annulled*)

CASE NO. 786

(*Interpretation of Specifications S-27*)

Inquiry: Is it permissible under the Code to make forged shells from steel complying with Specifications S-27, Grade B, instead of Specifications S-4, Class 2?

Reply: It is the opinion of the Committee that it is permissible to make this substitution provided the number of

test specimens, the number of tests and the method of taking the test specimens, and the bend tests comply with Specifications S-4. The chemical and other physical requirements should comply with Specifications S-27.

CASE No. 787

(Interpretation of Par. P-186)

Inquiry: The reply in Case No. 253 discourages the practise of welding short lengths of tubes together to make a usable length. The latest wording of Par. P-186 very definitely authorizes the practise of welding parts of boilers by electric-resistance butt welding. Should not this feature of Case No. 253 be annulled and will the Committee formally sanction lengthening tubes by welding two or more sections together under the provisions of Par. P-186?

Reply: In the opinion of the Committee it is permissible to join two or more sections of tubes by the methods prescribed in Par. P-186, and accordingly, that portion of Case No. 253 which conflicts therewith is hereby annulled.

CASE No. 788

(Interpretation of Par. P-260)

Inquiry: Par. P-260 of the Code requires manhole frames on shells or drums to be attached by riveting. Other paragraphs of the Code permit the welding on of boiler parts in various ways and for various purposes. Should not Par. P-260 have been revised to provide for welded construction? Would it not be within the present intent of the Code to attach manhole frames by welding?

Reply: The requirements of Par. P-260 should have been extended to include the attachment of manhole frames by welding. It is the opinion of the Committee that if the requirements of Pars. P-101 to P-111 and P-268, omitting X-raying, are complied with, the intent of the Code will be met.

CASE No. 789 *(In hands of Committee)*

CASE No. 790 *(In hands of Committee)*

CASE No. 791

(Interpretation of Par. P-299)

Inquiry: Par. P-299 of the Code requires that valves and fittings on water lines below the water line shall be equal at least to the requirements of the American Standards for a pressure 25 per cent in excess of the maximum allowable working pressure. This would apparently limit the use of the present 250-lb standard valves and fittings to 200-lb maximum allowable working pressure and also require a valve with a pressure rating of 313 lb to be used for 250-lb maximum allowable working pressure. Since there are no tables giving flange and body thicknesses for cast-iron valves and fittings over 250-lb pressure, will it be permissible to increase the flange and body thicknesses to permit the use of cast-iron valves and fittings on water lines below the water line, up through 250-lb maximum allowable working pressure?

Reply: It is the opinion of the Committee that the present 250-lb cast-iron flange and fitting standards should not be used for the purpose described for maximum allowable working pressures exceeding 200-lb per sq in. It is permissible to increase the flange and body thicknesses as described, maintaining the same deflection limits and to give at least the same factor of safety as for fittings specified in the 250-lb standard and use these valves and fittings up to 250-lb maximum allowable working pressure. The Committee recommends, however, that for the service stated, cast-iron valves or fittings be not used for pressures over 200 lb per sq in.

CASE No. 792 *(Special Case)*

Inquiry: In the fabrication of A.S.M.E. Code unfired pressure vessels, is it permissible to construct forged seamless vessels, to be used at temperatures not to exceed 700 F, of annealed austenitic chrome-nickel steel in accordance with specifications submitted (on file in Secretary's office) which have the following chemical and physical requirements:

Chromium, min., per cent	18.0
Nickel, min., per cent	8.5
Carbon, max., per cent	0.08
Manganese, per cent	0.20–0.70
Phosphorus, max., per cent	0.03
Sulphur, max., per cent	0.04
Silicon, max., per cent	0.70
Copper, max., per cent	0.50
Tensile strength, min., lb per sq in.	80,000
Yield point, min., lb per sq in.	35,000
Elongation in 2 in., min., per cent	35
Reduction of area, min., per cent	50

Reply: Pending the results of joint action of the Boiler Code Committee and the American Society for Testing Materials upon proposed specifications for the steel in question, it is the opinion of the Committee that forged seamless unfired pressure vessels may be constructed under the provisions of the Code provided the maximum unit working stress, at temperatures not to exceed 700 F, is 16,000 lb per sq in.

CASE No. 793 *(Special Case)*

Inquiry: In the fabrication of A.S.M.E. Code unfired pressure vessels, is it permissible to construct forged seamless vessels, to be used at temperatures not to exceed 450 F, of copper-nickel alloy in accordance with specifications submitted (on file in Secretary's office) which have the following chemical and physical requirements:

Copper, min., per cent	23.0
Nickel, min., per cent	60.0
Iron, max., per cent	3.5
Aluminum, max., per cent	0.5
Manganese, max., per cent	3.5
Carbon, max., per cent	0.3
Silicon, max., per cent	0.5
Forgings	
Tensile strength, min., lb per sq in.	80,000
Yield point, min., lb per sq in.	60,000
Elongation in 2 in., min., per cent	30
Reduction of area, min., per cent	40
Rolled Plate	
Tensile strength, min., lb per sq in.	60,000
Yield point, min., lb per sq in.	25,000
Elongation in 2 in., min., per cent	25
Reduction of area, min., per cent	40

Reply: Pending the results of joint action of the Boiler Code Committee and the American Society for Testing Materials upon proposed specifications for the material in question, it is the opinion of the Committee that forged seamless unfired pressure vessels may be constructed under the provisions of the Code provided the maximum unit working stress, at temperatures not to exceed 150 F, is 12,000 lb per sq in.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Vibrations in Bridges

A MATHEMATICAL TREATISE ON VIBRATIONS IN RAILWAY BRIDGES. By C. E. Inglis. University Press, Cambridge, 1934. Cloth, $7^1/_4 \times 10^1/_2$ in., 203 pp., 65 figs., $7.50.

REVIEWED BY S. TIMOSHENKO[1]

IT IS WELL known that dynamical stresses produced in a bridge by a moving locomotive are greater than the stresses produced by the same load if acting statically. To take into account the dynamical effect of moving loads it is general practise to multiply these loads by an "impact factor," the magnitude of which usually depends on the span of the bridge. The formulas used at present by bridge designers for determining this impact factor have no scientific foundation and it is quite natural at the present time, when the magnitudes of loads and the speed of motion are continuously increasing, that engineers are beginning to pay more attention to dynamical stresses. They are no longer satisfied with existing empirical formulas and are trying to replace them by more scientific methods of determining dynamical stresses in bridges.

During recent years considerable experimental and theoretical work has been done in various countries and some of the results obtained are already published.[2] C. E. Inglis' book on Vibrations in Railway Bridges contains the work done by him as a member of the British Bridge Stress Committee. It is principally a theoretical work consisting of the development of a satisfactory mathematical method for calculating bridge vibrations under various kinds of acting forces.

H. E. Angell

There are three principal causes of dynamical effect of moving loads on a bridge: (1) "Live-load effect" oi a smoothly running load, (2) dynamical effect of the balance weights of the locomotive driving wheels, and (3) impact effect due to irregularities in the track, such as rail joints, flat spots on wheels, etc. Mr. Inglis' book deals principally with "hammer-blows" due to the balance-weights which are attached to the driving-wheels of a locomotive

This problem can be greatly simplified by considering only the vertical component of the centrifugal force of a balance-weight as a pulsating force traveling along the bridge with a constant speed and further by neglecting the effect of moving masses on the bridge vibrations and also the effect of damping. The theoretical solution of this problem shows that the maximum amplitude of vibrations produced by such a pulsating force occurs when the frequency of the force is the same as the frequency of natural vibration of the bridge. Under

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[2] The results of British work have been published in the "Report of the Bridge Stress Committee," Department of Scientific and Industrial Research, London, 1928. The results of Russian work are published by N. Streletzky, see "Ergebnisse der experimentellen Brückenuntersuchungen," Berlin, 1928. The results of work done on railroad bridges in India are published in the "Bridge Sub-Committee Reports," 1925, Calcutta: Government of India Central Publication Branch, Technical Paper No. 247 (1926). Recent progress in the investigation of bridge vibrations was discussed at the last Congress of the International Association for Bridge and Structural Engineering, see Reports of Paris Congress, 1932.

this condition of "resonance" the amplitude of vibrations is building up during the traveling of the pulsating force and becomes maximum at the instant when the force is leaving the bridge. Quite naturally the magnitude of vibrations calculated in this manner is larger than the actual vibrations which have been observed on bridges. In order to eliminate this discrepancy between the theory and the experiment, the effect of moving masses on the bridge vibrations and also the effect of damping should be considered.

Mr. Inglis takes both these factors into consideration and gives several approximate methods of handling the complicated differential equation representing vibration of a bridge under such general conditions. His analysis shows that with respect to the effect of "hammer blows" bridges can be divided into three groups: Large-span bridges ($l >$ 250 feet), medium-span bridges ($100 < l <$ 250 feet) and short-span bridges ($l <$ 50 feet).

In the case of large bridges the frequency of vibrations is comparatively small and the corresponding vertical inertia forces of a locomotive are not sufficient to overcome the friction in its spring movement. Hence for long-span bridges, a locomotive, in moving across a bridge, behaves as though its springs were locked, and in considering vibrations the total mass of the locomotive should be taken into account. The natural frequency of vibration of the bridge due to the action of the moving mass of the locomotive becomes variable and the differential equation of vibration is a very complicated one. Mr. Inglis shows by his analysis that without making a serious error the variable frequency can be replaced by a constant frequency and derives on the basis of this assumption a very simple formula for calculating vibrations produced by "hammer blows." The calculations made in this manner are in very good agreement with the experiments.

In the case of medium spans the vertical accelerations in the bridge are of such magnitude that the locomotive springs must inevitably be set in motion, and it is necessary to consider the interdependent simultaneous vibrations of the locomotive and of the bridge. Analyzing this complicated problem Mr. Inglis comes to the conclusion that the amplitude of forced vibrations in this case can be obtained with sufficient accuracy by treating the locomotive as stationary at the middle of the bridge and skidding its wheels at the speed which is in resonance with the fre· vibration of the bridge. This approximation is · based on the fact that, owing to the very heavy extra damping introduced by spring movement, the bridge oscillations mount up approximately to their maximum in a very short interval of time, and at the end of the first half second they will fall short of this limit only by about 10 per cent. For a bridge of 100-foot span or more, a locomotive, even when traveling at high speed, is in the middle third of the span for at least half a second and, consequently, there is time for the oscillations to build up to very nearly the full value which they would attain if the locomotive remained permanently skidding at the middle of the bridge. The calculations made on the basis of such an approximate theory again are in very satisfactory agreement with the experimental results obtained by the Bridge Stress Committee.

In the case of short bridges the frequency of free vibrations is large in comparison with the frequency of the pulsating force which is equal to the number of revolutions of the drivers per second. Under such conditions the dynamical deflections can be predicted with sufficient accuracy by treating the effect of centrifugal forces of balance weights as purely static.

In calculating bridge vibrations it is necessary to have information regarding natural frequencies of vibrations of bridges and damping in bridges and also regarding frequencies of vibrations of locomotives, friction in locomotive springs and magnitude of balance weights. Some information regarding these quantities, which were obtained from experiments by the British Bridge Stress Committee, are also given in this book.

From the above discussion it is seen that Mr. Inglis' book is a complete treatise on vibration of bridges. It contains not only complete theoretical solutions of a series of important vibration problems but also some approximate solutions, which resulted in comparatively simple formulas that can be easily applied in practise and the accuracy of which is checked by the exact solutions and by comparisons with experiments. This book represents a great accomplishment in the field of dynamics of bridges and it can be recommended to all engineers interested in bridge vibrations.

Books Received in Library

A.S.T.M. STANDARDS ON COAL AND COKE, prepared by Committee D-5 on Coal and Coke, September, 1934. American Society for Testing Materials, Philadelphia, Pa. Paper 6 × 9 in., 108 pp., diagrams, tables, $1. Five specifications, thirteen methods of test, and the standard definitions of terms relating to coal and coke are conveniently brought together in this publication, which includes all the material on the subject which the Society has issued. The recently approved r quirements for classification of coal are also included.

A.S.T.M. STANDARDS ON PETROLEUM PRODUCTS AND LUBRICANTS, prepared by Committee D-2 on Petroleum Products and Lubricants, September, 1934. American Society for Testing Materials, Philadelphia, Pa., 1934. Paper, 6 × 9 in., 340 pp., illus., diagrams, charts, tables, $1.75. All the test methods, specifications, and definitions of terms referring to these materials which the Society has issued are included in this volume. In addition, there are included the reports of the committees on petroleum products and lubricants, and on gasoline. New standards are given covering fuel oils, emulsified asphalts, the gum content of gasoline, and the separation of liquid-asphaltic products. Among the revisions of test methods are those for sulphur in petroleum oils, the color of lubricating oils, and for emulsified asphalt. In all, there are fifty-three test methods and six specifications.

CHEMICAL ENGINEERING CATALOG. Nineteenth edition. 1934. Reinhold Publishing Corporation, New York, 1934. Leather, 8 × 11 in., 779 pp., illus., diagrams, charts, tables, $3. This valuable reference book provides essential information for purchasers of chemical engineering equipment and supplies, chemicals, and raw materials. Catalog data of many firms are given, with good indexes. In addition to the main divisions of the book, there is included a useful index of trade names, and extensive lists of technical and scientific books, arranged by author and subject.

CHEMISTRY OF SOLIDS. (The George Fisher Baker Non-Resident Lectureship in Chemistry at Cornell University.) By C. H. Desch. Cornell University Press, Ithaca, N. Y., 1934. Cloth, 6 × 9 in., 213 pp., illus., diagrams, charts, tables, $2.50. This book contains the substance of the George Fisher Lectures at Cornell University, 1931–1932. As it is not possible yet to give a systematic account of the chemical properties of solids. Dr. Baker has selected certain topics with the aim of indicating the directions in which research is proceeding and of stimulating thought upon this branch of chemistry. The composition of solids, crystal growth and structure, surface films and passivity, abrasion and corrosion fatigue, the structure of iron, ageing and age hardening, and intermetallic compounds are among the subjects discussed.

DAMPFKESSEL-SPEISEPUMPEN. Bemessung, Ausführung, Antrieb und Regelung. By K. Grün. Julius Springer, Vienna, 1934. Paper, 6 × 9 in., 136 pp., illus., diagrams, charts, tables, 7.50 rm. The object of this book is to provide practical guidance in the choice, installation, and operation of boiler-feed pumps for stationary steam plants. A section on general principles begins the study, after which the various types of pumps are discussed with respect to their construction, capacities, regulation, etc. Succeeding chapters consider methods of driving, feed-pump governors, the arrangement of feed-pump installations, and economics. Although intended primarily for the operating engineer, the book will also interest pump manufacturers and designers.

DAVISON'S TEXTILE CATALOGUES AND BUYERS' GUIDE, 1934. Fiftieth edition, Davison Publishing Co., New York. Cloth 9 × 12 in., 320 pp., illus., $12. The catalog section of this volume contains condensed catalogs of over two hundred manufacturers of machinery and supplies for textile mills. The buyers' guide lists several thousand makers of supplies and services under almost twenty-five hundred headings. Mill operators and purchasing agents will find the volume most convenient.

DEUTSCHES MUSEUM, ABHANDLUNGEN UND BERICHTE, Vol. 6, Part 2. OSKAR VON MILLER. By J. Zenneck. Berlin, V.D.I. Verlag, 1934. Paper, 6 × 9 in., 50 pp., illus., 90 rm. A memorial address upon the great engineer, delivered at the annual meeting of the Deutsches Museum in 1934, shortly after his death. Dr. Zenneck gives an admirable review of Miller's work as an engineer and as founder and organizer of the great technical museum.

DIE CASTINGS, Their Design, Composition, Application, Specification, Testing, and Finishing. By H. Chase. John Wiley & Sons, New York, 1934. Cloth, 6 × 9 in., 264 pp., illus., diagrams, tables, $3.50. Die-casting is discussed from the viewpoint of the user rather than the producer. An introductory chapter discussing the advantages of die castings, is followed by one showing many applications in the manufacture of automobiles, household and office appliances, hardware, machines, etc. Succeeding chapters discuss the alloys used, the design of castings, specifications and tests, and finishes. Much practical information is given in convenient form.

DIESEL ENGINEERING HANDBOOK (formerly the Diesel Power Plant Handbook). Seventh edition. Edited by L. H. Morrison and T. A. Burdick. Business Journals, Inc., New York, 1934. Leather, 9 × 12 in., 320 pp., illus., diagrams, charts, tables, $5. A compendium of miscellaneous information upon the Diesel engine and its uses. The basic principles are discussed, data are given on production and economics, and modern designs are described. A chapter is devoted to supercharging and scavenging, and another to lubricants and fuels. Oil purification is discussed. Other chapters consider plant planning, water-cooling systems, Diesel-electric stations, operation, maintenance, uses in transportation, etc. A catalog section closes the volume.

EDISON, His Life, His Work, His Genius. By W. A. Simonds. Bobbs-Merrill Co., Indianapolis and New York, 1934. Cloth, 6 × 9 in., 364 pp., illus., $3.50. Mr. Simonds has devoted several years to this book. He has carefully studied the collection of Edisonia at the Edison Institute, visited the scenes of Edison's life and consulted his associates widely. The result is an interesting, readable book, which corrects a number of current errors and legends, and supplies a valuable picture of the man and his work.

FORSCHUNGSHEFT 367. DAS TOEPLERSCHE SCHLIERENVERFAHREN, Grundlagen für seine Anwendung und quantitative Auswertung. V.D.I. Verlag, Berlin, 1934. Paper, 8 × 12 in., 32 pp., illus., diagrams, charts, tables, 5 rm. Toepler's "method of striae" is an ingenious method for making visible those regions in a transparent medium which have a slightly different refractive index from surrounding regions. The method is used to study the flow of liquids and gases, flow at high velocities, acoustic and thermodynamic phenomena, and similar questions. The present work is the first to present a systematic account of the principles underlying the method and a review of its uses and applications.

HISTORY OF RENSSELAER POLYTECHNIC INSTITUTE, 1824–1934. By P. C. Ricketts. Third edition. John Wiley & Sons, New York, 1934. Cloth, 6 × 9 in., 293 pp., illus., $3.50. President Ricketts began his association with Rensselaer in 1871, when he entered as a student, and has continued with it as professor and executive until today. He has seen it grow from an institution with 150 students to one ten times as large. This long personal acquaintance has enabled him to write an admirable account of the founding of the school and its development during its long life. As the history of the oldest American engineering school, the work is of interest to students of education generally, as well as to the alumni of Rensselaer.

"HÜTTE" DES INGENIEURS TASCHENBUCH. Twenty-sixth edition. Vol. 3, No. 2. Edited by Akademischer Verein Hütte. Wilhelm Ernst & Sohn, Berlin, 1934. Paper, 5 × 8 in., pp. 677–1204, diagrams, charts, tables, 7 rm. This publication completes volume 3 of this well-known handbook and includes the sections devoted to road building and regional planning, bridge building, and railroads, together with fifteen appendixes of standards, specifications and tables, and an index to the whole volume. The section on roads has been considerably enlarged and that on bridge building entirely rewritten. The railroad section has been partly rewritten and rearranged; it comprises railroad construction, motive power, shops, mountain railroads, and rapid transit.

HYDRAULICS. By E. W. Schoder and F. M. Dawson. Second edition. McGraw-Hill Book Co., New York and London, 1934. Cloth, 6 × 9 in., 429 pp., illus., diagrams, charts, tables, $3.50. This is intended as a basic course in the hydraulics of engineering which will serve both as an introduction to specialized studies and a text and reference book on everyday problems. The physical phenomena of hydraulics are described, particularly from the engineer's point of view; fundamentals are developed into useful formulas; and numerous examples of the analysis and solution of typical practical problems are given. The new edition has been enlarged and thoroughly revised.

HYDRAULICS OF FLOOD MOVEMENTS IN RIVERS. By H. A. Thomas. Carnegie Institute of Technology, Pittsburgh, 1934. Paper, 6 × 9 in., 70 pp., diagrams, charts, tables. The purpose of this pamphlet is to present those elements of the hydraulic theory of unsteady flow in open channels which are needed in the solution of problems pertaining to the movement of flood waves in rivers, and to discuss various approximate methods that have been used for handling them. Much in the work has not been published before or is not readily available to engineers, and as the subject receives little attention in standard texts on hydraulics, it will be useful to engineers interested in flood control.

INTRODUCTION TO MECHANICS AND HEAT. By N. H. Frank. McGraw-Hill Book Co., New York and London, 1934. Cloth, 6 × 9 in., 339 pp., diagrams, $3. This text represents the basic elementary course required for all but a few students at the Massachusetts Institute of Technology. The course is intended to lay a thorough quantitative foundation, by a logical unified treatment of mechanics, acoustics, and heat, which will teach the student to appreciate and utilize fundamental and general methods of attack on problems in all branches of physics.

INTRODUCTION TO QUANTUM THEORY. By G. Temple. D. Van Nostrand, New York, 1934. Cloth, 6 × 9 in., 196 pp., diagrams, $3.75. Being intended as an introduction, the present book is more concerned with the historical and philosophical matrix from which the quantum theory has crystallized than with the theory itself. The work opens with an account of the principle of duality and its implications in electromagnetic theory. Following this, the field theory of matter is introduced as a means to pass from the classical to the quantum key. Succeeding chapters discuss quantum algebra, matrix mechanics, the relativistic wave equation and the spinning electron.

LOCKWOOD'S DIRECTORY OF THE PAPER AND ALLIED TRADES. Fifty-ninth edition, Lockwood Trade Journal Co., New York, 1934. Cloth, 6 × 9 in., 1092 pp., illus., $7.50. This annual provides a very complete directory of the American paper industry in all its branches. Included are directories of paper- and pulp-mill officials, of paper and pulp mills, of manufacturers of various papers and paper goods, of watermarks and brands, of trade associations, and of equipment and supply houses. The information about mills is especially complete and includes officials, equipment, capacity, products, etc.

MACHINERY'S HANDBOOK FOR MACHINE SHOP AND DRAFTING-ROOM. Ninth edition. Industrial Press, New York, 1934. Leather, 5 × 7 in., 1592 pp., diagrams, charts, tables, $6. This well-known handbook aims to provide the data frequently wanted by machine designers and builders in a convenient, easily consulted form. Much practical information upon the strength of materials, gearing, bolts and screws, speeds and feeds, fits, screw threads, heat treatment, pipe fittings, etc., is presented. The new edition has been revised to include new standards and late practise in designing and manufacturing.

LES MACHINES ASYNCHRONES à Champs Tournants, à Bagues et à Collecteur. By R. Langlois-Berthelot. Second edition. Dunod, Paris, 1934. Cloth and paper, 6 × 9 in., 274 pp., illus., diagrams, charts, tables; cloth, 63.50 fr.; paper, 53.50 fr. This volume represents the course given at the École Supérieure de l'Électricité, Paris, and constitutes essentially a general method for studying asynchronous machines. An introductory chapter describes the industrial properties of these machines, after which a general theory is developed. This section, forming the major part of the book, is clear and full. A final section, on design, illustrates the application of the theory to the design of the more important types.

DAS MASCHINENZEICHNEN MIT EINFÜHRUNG IN DAS KONSTRUIEREN. (Sammlung Göschen Band 590.) By W. Tochtermann. II, Ausgeführte Konstruktionsbeispiele. Walter de Gruyter, Berlin and Leipzig, 1934. Cloth, 4 × 6 in., 130 pp., diagrams, charts, tables, 1.62 rm. This little volume forms part of a course in mechanical drawing. It contains a collection of simple machine elements, represented by drawings showing how these are properly

drawn. The drawings are accompanied by detailed explanations, in which the use of the elements, the calculation of dimensions, etc. are discussed.

MITTEILUNGEN AUS DEN FORSCHUNGSANSTALTEN GHH-KONZERN. Vol. 3, No. 5, October, 1934. V.D.I. Verlag, Berlin. Paper, 8 × 12 in., pp. 111–140, illus., diagrams, charts, tables, 3.40 rm. The first of these papers describes comparison tests of two planers, one driven by a reversible electric motor, the other using an oil drive. The second, on experimental work and developments in river-boat building, reviews the advances during the past two decades. The final paper, upon the measurement of the internal friction of metals, discusses the applicability and simplification of experimental methods, and describes a new apparatus for the measurement.

PRINCIPLES OF MATHEMATICAL PHYSICS. By W. V. Houston. McGraw-Hill Book Co., New York and London, 1934. Cloth, 6 × 9 in., 265 pp., diagrams, tables, $3.50. This text is intended to give students who have a thorough knowledge of elementary physics, analytical geometry, and calculus, a working knowledge of the fundamental methods of mathematical physics which will enable them to use the more powerful methods of treating physical problems by applying them to simple cases and includes, as an integral part of the text, numerous problems.

PRINCIPLES OF MECHANISM. By C. E. Pearce. John Wiley & Sons, New York, 1934. Cloth, 6 × 9 in., 283 pp., illus., diagrams, charts, tables, $3.50. A textbook for college sophomore classes whose students have no preparation beyond high-school physics and college trigonometry, and no great familiarity with various kinds of machinery. The book offers an introductory course, confined largely to the more common forms of the five types of mechanisms and of the wheel trains. The advantages, possibilities, and limitations of these are discussed, and numerous problems are provided.

PROBLEMS IN ENGINEERING THERMODYNAMICS AND HEAT ENGINEERING. By C. W. Berry, C. L. Svenson, and H. C. Moore. John Wiley & Sons, New York, 1934. Paper, 6 × 9 in., 178 pp., illus., $1.25. Over one thousand theoretical and practical problems, with answers, are included. The problems are printed on one side and the pages perforated, so that the statement can be cut out and attached to the solution. The problems are typical of those given to students in various undergraduate and advanced courses at the Massachusetts Institute of Technology.

REGELN FÜR ABNAHME- UND LEISTUNGSVERSUCHE AN VERDICHTERN. V.D.I. Berdichter-Regeln. DIN 1945. Third edition. Edited by Verein deutscher Ingenieure. V.D.I. Verlag, Berlin, 1934. Paper, 8 × 12 in., 54 pp., diagrams, charts, tables, 5 rm. This publication gives the regulations for acceptance and duty tests of fans and compressors which are approved by the Verein deutscher Ingenieure. In addition to the rules, measuring instruments and methods are described, and the necessary mathematical and physical data are included. Specimen reports upon tests of a variety of fans and compressors are given.

RIVETING AND ARC WELDING IN SHIP CONSTRUCTION. By H. E. Rossell. Simmons-Boardman Publishing Co., New York, Chicago, and San Francisco, 1934. Cloth, 5 × 8 in., 210 pp., diagrams, charts, tables, $2.25. As the hull of a ship is made of plates and shapes, the methods available for joining these largely dictate the type of construction which must be employed, and the principles that underlie the design of joints in structures are therefore of fundamental importance to the naval architect. In this work, the author discusses riveted and arc-welded joints from both the practical and theoretical points of view, with special reference to ship design and construction.

SCIENCE MUSEUM, SOUTH KENSINGTON. FIVE YEAR BIBLIOGRAPHY OF THE THEORY OF REFRIGERATION, REFRIGERANTS, AND APPLIANCES, 1929–1933. Compiled by H. T. Pledge. His Majesty's Stationery Office, London, 1934. Paper, 8 × 13 in., 97 pp., $0.65. A useful bibliography covering the years 1929 to 1933 and containing about eight hundred entries. The theory of refrigeration, refrigerants, refrigerating plants and their construction, the theory of refrigerating machines, methods of refrigerating, machine parts, domestic refrigerators, ice manufacture, and refrigerating in air-conditioning are the principal topics included. The material is classified by the Universal decimal system.

SEAPLANE DESIGN. By W. Nelson. McGraw-Hill Book Co., New York & London, 1934. Cloth, 6 × 9 in., 274 pp., illus., diagrams, charts, tables, $3.50. This book is a compilation of the literature upon seaplane design, with emphasis upon those features that distinguish it from airplane design. Displacement and buoyancy, stability afloat, float forms and arrangements, structural features, and other practical matters are discussed.

SERVICE CHARACTERISTICS OF THE LIGHT METALS AND THEIR ALLOYS, prepared by Subcommittee VII of Committee B-7 on Light Metals and Alloys, Cast and Wrought. American Society for Testing Materials, Philadelphia, 1934. Paper, 6 × 9 in., Vol. 34, Part 1, 33 pp., tables, $0.50. This pamphlet is intended to present the essential data about aluminum and magnesium and their more important alloys in a concise form. The metallurgical characteristics of the metals are discussed. Their usefulness in certain industrial fields is explained, surface protection by painting, anodizing, or electroplating is described, and tables are given of the trade designations, compositions, physical constants, mechanical properties, and foundry characteristics of various alloys.

SYMPOSIUM ON THE OUTDOOR WEATHERING OF METALS AND METALLIC COATINGS. Washington Regional Meeting, American Society for Testing Materials, March 7, 1934. A.S.T.M., Philadelphia, 113 pp., illus., diagrams, charts, tables, $1.50. The material that appears in this volume was presented at a symposium held in Washington in 1934. Primarily, the papers are an analysis of performance data obtained from outdoor weathering tests conducted by the American Society for Testing Materials and other investigations, and are intended to show how these data may be used to solve practical problems. Five papers, with discussions, are given: Outdoor test results on bare and metal-coated ferrous specimens; the harmony of outdoor weathering tests; influence of rainfall and smoke on the corrosion of iron and steel; early interpretation of test results in the atmospheric corrosion of non-ferrous metals and alloys; galvanic corrosion by contact of dissimilar metals.

SIGNIFICANCE OF TESTS OF PETROLEUM PRODUCTS, a Report Prepared by A.S.T.M. Committee D-2 on Petroleum Products and Lubricants. American Society for Testing Materials, Philadelphia, Pa., 1934. Paper 6 × 9 in., 76 pp., charts, tables, $1. This report is intended to give the general public authoritative information about the applicability of the tests in common use for petroleum products and lubricants, and the significance of the results. It aims to assist in the proper choice of tests and their correct interpretation. The book will be very useful to users of petroleum products, as a concise, definite summary of practical information in convenient form.

TECHNICS AND CIVILIZATION. By L. Mumford. Harcourt, Brace & Co., New York, 1934. Cloth, 6 × 10 in., 495 pp., illus., $4.50. An interesting, thought-provoking book, in which the author attempts to explain the origin of the machine and to trace its influence upon the material prosperity and culture of western civilization during the last millennium. While the sociological aspects of the question are emphasized, the work also has much merit as a history of technical development. Appended to the book are an interesting chronological table of inventions and a good bibliography.

TECHNISCH-PHYSIKALISCHES PRAKTIKUM, ausgewahlte Untersuchungsmethoden der technischen Physik. By O. Knoblauch and W. Koch. Julius Springer, Berlin, 1934. Cloth, 6 × 10 in., 167 pp., diagrams, charts, tables, 13.50 rm. This volume contains detailed practical methods for various physical measurements, such as temperature, heat conductivity, heat transfer, pressure and velocity, and sound conductivity, with examples of their practical applications in engineering research. The collection is intended to meet the needs of engineers who are engaged in investigations that call for the accurate measurement of physical properties under practical conditions.

WHO GETS THE MONEY? How the People's Income Is Distributed. By W. Rautenstrauch. Harper & Brothers, New York and London, 1934. Cardboard, 5 × 8 in., 99 pp., charts, tables, $1. Dr. Rautenstrauch's contribution to the discussion of the economic crisis is concerned with the costs of producing the national income and with its distribution. These problems he considers from an engineer's point of view. The first section of his book tells the story of the origin of our difficulties in simple fashion. The second presents in detail the statistics that underlie his conclusions. The author ascribes most of our present economic troubles to undue overhead costs in the national industrial plant.

ZERSPANNUNG UND WERKSTOFF, Ein Handbuch für den Betrieb. By E. Bröedner. V.D.I. Verlag, Berlin, 1934. Cloth, 6 × 8 in., 173 pp., illus., diagrams, charts, tables, 5 rm. Dr. Bröedner has undertaken to review critically the mass of information upon metal cutting which has appeared in the technical press during recent years, and to present the results in convenient form. The basic principles of metal cutting, cutting lubricants and cooling liquids, turning, boring, milling, and grinding are considered in part one; part two discusses the properties of metals which affect their workability and their suitability as tools. The book closes with an extensive bibliography. A great amount of practical information is presented in a useful way.

WHAT'S GOING ON

Actions of A.S.M.E. Council

THE following actions of general interest were taken at the December 3 and 7 meetings of the Council of The American Society of Mechanical Engineers:

MID-WEST OFFICE

Following a report by James A. Hall on the Mid-West office, the recommendation of the Executive Committee of Council with respect to it, and a full discussion, including resolutions from the Local Sections' Delegates Conference, it was voted that the Mid-West office be kept open until the 1935 Semi-Annual Meeting and that the Executive Committee of Council be requested to review the situation at that time in the light of conditions as they will then exist.

DELINQUENT MEMBERS

It was voted to approve the procedure for delinquent members as outlined in the report of the Board of Review and to appoint that Board to advise the Council in administering the policy recommended. The Board's recommendations were as follows:

The experience of the lenient policy that the Society has extended to members in arrears during the past four years has led to the suspension, loss of seniority, or dropping of over five thousand members on September 30, 1934. To avoid a repetition of this in the future, it is recommended that the Society adhere to the present rules as set forth in Article B5, Fees and Dues, with the exceptions as here and after set forth:

"Par. 3. A member whose dues shall remain unpaid for three (3) months shall not be entitled to the publications until his dues are paid.

"Par. 4. A member whose dues shall remain unpaid for twelve (12) months, shall, in the discretion of the Council, be stricken from the roll of membership and shall cease to have any further rights as a member.

"Par. 6. At its first meeting in the calendar year the Secretary shall submit to the Council a list of the delinquents for action thereon in respect to their rights to vote and receive publications.

"Par. 7. At its first meeting after the close of the fiscal year on September 30th, the Secretary shall submit to the Council a list of delinquents for its action thereon in respect to their continuance on the rolls of the Society and retaining rights as members."

In order to clear up the present membership status an analysis of the membership as of October 1, 1934, includes:

(1) 10,782 dues paid in full for September 30, 1934
(2) 1,241 have paid partial payment on 1934 dues
(3) 1,456 owe the 1934 dues in full
(4) 535 owe a balance on 1933 dues plus full 1934 dues
(5) 95 owe a balance on "loss of seniority" plan, plus 1935 dues
(6) 185 owe two years or more dues to September 30, 1934, from whom definite promise of payment has been received.

Re Group (1), no action is necessary.

Re Group (2), it is recommended for this year only that they be given until April 1, 1935, in which to complete payment of all dues owing to September 30, 1934, and at least one quarter of current (1935) dues by that time or they shall not be entitled to receive further publications.

Re Group (3), it is recommended that complete payment of all dues owing to September 30, 1934, be paid not later than April 1, 1935, or delinquent's name shall be submitted to Council to be dropped. Upon partial payment of 1934 dues prior to April 1, 1935, these members are to be considered the same as those in group (2).

Re Groups (4) and (6), all 1933 and at least a quarter payment of 1934 dues must be made by April 1, 1935, or these members will be dropped on that date.

Re Group (5), complete payment on loss of seniority plans must be received by April 1, 1935, plus one quarter of 1935 dues or from that date these members shall not be entitled to receive further publications.

Members who have been suspended in accordance with the policy adopted by the Executive Committee of Council at its meeting on April 21, 1934, may apply for return to active status prior to September 30, 1936. Full payment of the dues for the year in which the member applies for reinstatement must accompany his request.

The present policy of reinstating resigned members should be continued, namely, that the resigned member applying for reinstatement within one year of date of resignation is not required to pay a new initiation fee. Resigned members applying for reinstatement after one year are to be treated as new members.

The present policy of reinstating dropped members by payment of new initiation fee plus one year of their dues arrears should be continued in effect, except that no dues in arrears shall be required from those applying for reinstatement prior to September 30, 1936. If and when the above is approved the Board of Review believes that it is information which in whole or in part should be made available to such members and former members as the occasion requires.

It is further recommended that during the present period of economic depression a member's dues may be canceled after such member has submitted a written statement as to his ability to make payment, special consideration being given to tenure of membership in the Society. With the cancelation of such dues, membership privileges shall cease for the period in which the dues are canceled.

SOCIETY PURPOSES

As recommended by the Committee on Policies and Budget, an amendment to the By-Laws containing the statement of Society purposes was adopted. The statement is as follows:

ARTICLE B2, PAR. 1—PURPOSES

Par. 1. The objectives of the Society shall be accomplished by:

A Advancing the theory and practise of engineering and the allied arts and sciences by:

(*a*) Encouraging engineering research, tests, and other original work.

(*b*) Encouraging the preparation of original papers on engineering topics.

(*c*) Holding meetings for the presentation and discussion of original papers and participating in international engineering congresses.

(*d*) Publishing papers and reports and disseminating knowledge and experience of value to engineers.

(*e*) Developing and promulgating standards, codes, formulas, and recommended practises.

(*f*) Offering awards and other honors to encourage contributions to engineering; conferring awards and other honors in recognition of meritorious contributions to engineering.

(*g*) Furthering the purposes of the Engineering Societies' Library, of which the library of this Society forms a part.

(*h*) Encouraging intercourse among engineers for the mutual exchange of knowledge and experience.

B Enhancing the status of the engineer by:

(*a*) Maintaining high technical and cultural standards for entrance to the Society.

(*b*) Cooperating with educational institutions in the maintenance of high standards of engineering education.

(*c*) Requiring a high standard of ethical practise by members of the Society.

(*d*) Aiding in the adoption of a high standard of attainment for the granting of the legal right to practise professional engineering.

(*e*) Fostering among engineering students the study of the philosophy and history, tradition and achievement, duties, and social functions of the engineering profession.

(*f*) Encouraging the personal and professional development of young engineers.

(*g*) Supporting activities looking to the increased employment of engineers and seeking new opportunities for engineering service.

C Increasing the usefulness of the organized engineering profession by:

(*a*) Cooperating with other engineering and technical societies.

(*b*) Encouraging a high standard of citizenship among engineers.

(*c*) Encouraging engineers to participate in public affairs.

(*d*) Cooperating with governmental agencies in engineering matters.

(*e*) Publicity for the engineering profession through the achievements of engineers.

CHANGES IN MEMBERSHIP GRADES

The Committee on Policies and Budget asked for authority to draft an amendment to the Constitution to cover changes in membership grades, for presentation at the Semi-Annual Meeting. Such authority was granted. The recommendations of the E.C.P.D. that the Founder Societies establish uniform grades of

membership led to the need for a recommendation on a proposed change in the Constitution.

SOCIETY ORGANIZATION

On the recommendation of the Committee on Policies and Budget it was voted to establish at once, under the direction of the Council, an Advisory Board on Technology and an Advisory Board on Standards and Codes. These Boards are to continue for two years and to report to Council as to possible modification that should be made in their functions and continuance. The Boards are to consider the broad aspects of plans and policy for advancing the technical interests of the Society. They are advisory in nature and have no mandatory powers. Appointments of chairmen of these Boards was subsequently announced as follows: Advisory Board on Technology, A. A. Potter; Advisory Board on Standards and Codes, Alex D. Bailey.

The Advisory Board on Technology is to consist of five, a chairman from the Council, named by the President, and one member of each of the following Standing Committees: Meetings and Program, Professional Divisions, Research, and Publications.

Under the direction of the Council the Advisory Board on Technology shall:

(1) Assume the responsibility of coordinating the activities of the general meetings and congresses, divisions, research, and publications of the Society.

(2) Assume the responsibility of leadership and initiative with respect to coordination.

(3) Interpret the provisions of the Society's By-Laws concerning the jurisdictions and policies of the several committees represented on the Board.

(4) Review and recommend policies proposed by the several committees for the control of their activities.

(5) Hold at least two meetings each year.

The Advisory Board on Standards and Codes is to consist of five, a chairman from the Council named by the President and one member of each of the following four committees: Boiler Code, Standardization, Power Test Codes, and Safety.

The Advisory Board on Standards and Codes shall be advisory to Council and shall assist in:

(1) Establishing general policies pertaining to standards and codes.

(2) Initiating and developing standards and codes.

(3) Coordinating the activities of the several committees represented in its membership.

In further report on the work of the Committee on Policies and Budget, Mr. Westcott, chairman, discussed informally the Committee's tentative conclusion that the Council itself is too large. The tentative suggestion was made for a council consisting of seven members in addition to the president and a vice-president. No recommendation was made but suggestions and comments were invited.

LOCAL SECTIONS' DELEGATES

Jiles W. Haney, chairman, Committee on Local Sections, reported that the Local Sections' Delegates had been in almost constant deliberation throughout the week. He introduced S. R. Dows, of Albany, Calif., representative of Group 7, who presented to the Council the report and recommendations of the Conference of Local Sections' Delegates. The report was accepted with a vote of sincere appreciation and will be acted upon at later meetings after opportunity for study has been afforded.

ENGINEERING HISTORY

As a result of a session of the Annual Meeting at which the subject of the history of engineering was discussed, a resolution was presented to Council recommending the formation of a body to encourage the study of this subject. It was voted to approve the recommendation and to appoint a committee to further the organization.

CALVIN W. RICE MEMORIAL

A report of a special committee on the Calvin W. Rice Memorial was received. The committee is as follows: H. N. Davis, chairman, W. F. Durand, C. E. Fuller (representing Karl T. Compton), J. W. Parker, J. D. Cunningham, R. L. Sackett, C. N. Lauer, and E. W. O'Brien.

STUDY OF COAL

It was voted to approve as submitted the preliminary report of the Joint Committee (A.I.M.E and A.S.M.E., see MECHANICAL ENGINEERING, August, 1934, p. 510) and to authorize its release to the technical press.

E.C.P.D. PLAN OF CERTIFICATION

It was voted to approve the E.C.P.D. plan of certification into the profession. (This plan will be published in a later issue of MECHANICAL ENGINEERING.—Editor.)

RELATIONS WITH COLLEGES

W. L. Abbott reported for the Committee on Relations With Colleges that Ernest Hartford, assistant secretary, A.S.M.E., had covered 15,000 miles of travel in ten weeks, addressing 60 organizations consisting mainly of student branches and local sections. The result of these visits was satisfactory and the committee congratulated itself on the work of its secretary in introducing the new plan into 29 student branches in groups 6 and 7.

ALLOWANCES FOR NOMINATING COMMITTEE

As a result of a plea made by C. P. Bliss, it was voted to grant members of the Nominating Committee a per diem allowance within the appropriation allotted to that committee for certain time spent in the work of that committee.

RETIRING COUNCIL MEMBERS

President Doty extended his sincere appreciation to each retiring officer of the Council.

1934–1935 COUNCIL CONVENES

At the close of the concluding meeting of the 1933–1934 Council, President Doty introduced the new members of the Council as follows: President, Ralph E. Flanders; vice-presidents, Eugene W. O'Brien, James H. Herron, and Harry R. Westcott; managers, Bennett M. Brigman, Jiles W. Haney, and Alfred Iddles. (Mr. Iddles was not present.) Biographical sketches of the new members will be found on pages 503 to 506 of the August issue of MECHANICAL ENGINEERING. The gavel having been handed to President Flanders, the new council convened.

SECRETARY AND TREASURER APPOINTED

C. E. Davies was unanimously appointed secretary of the Society. Erik Oberg was appointed treasurer of the Society for the year ending with the 1935 Annual Meeting, to serve without salary.

EXECUTIVE COMMITTEE

The personnel of the Executive Committee of Council was announced as follows: Ralph E. Flanders, chairman, William L. Batt, Harry R. Westcott, James A. Hall, and Alfred Iddles. In announcing the appointments it was pointed out that practical considerations demand that men living within easy access of New York be named.

AMERICAN ENGINEERING COUNCIL

It was voted that the Society commit itself at this time to a minimum appropriation for the American Engineering Council of $8000 for the twelve-month period, reconsideration to be given to this action at the Semi-Annual Meeting in June in the hope that increased revenue might make possible a greater appropriation.

MANUAL OF PRACTISE

Theodore Baumeister, Jr., presented a report on behalf of the Committee on Manual of Practise (see MECHANICAL ENGINEERING, November, 1933, page 711). It was voted to approve the procedure outlined by the committee and to approve the immediate publication of the report. (The report will be published in MECHANICAL ENGINEERING at any early date.)

WESTINGHOUSE MEMORIAL

Following a report by C. N. Lauer, it was voted to appoint a committee to make plans for the 90th anniversary in 1936 of the birth of George Westinghouse, past-president, A.S.M.E.

SEMI-ANNUAL MEETING, CINCINNATI, JUNE 19 TO 21, 1935

On the recommendation of the Committees on Meetings and Program, Professional Divisions, and Local Sections, it was voted to hold the 1935 Semi-Annual Meeting at Cincinnati, Ohio, June 19, 20, and 21, and to hold the 1936 Semi-Annual Meeting in Texas.

Actions of A.S.M.E. Executive Committee

THE following actions of the A.S.M.E. Executive Committee are those of general interest taken by the 1933–1934 Committee at its meeting of December 2, and by the 1934–1935 Committee at its meeting of December 7. In the case of the former meeting, business reported under the "Actions of the A.S.M.E. Council" is omitted.

The following appointments were voted:

Committee on Employment, W. A. Shoudy, J. N. Landis, and Crosby Field; Committee on Honors, William L. Batt, H. Diederichs, R. C. H. Heck, L. P. Alford, and Harte Cooke; Committee on Public Affairs, Roy V. Wright, chairman, L. P. Alford, Paul Doty, R. E. Flanders, A. A. Potter, J. W. Roe, and D. Robert Yarnall. Committee on Inter-Society Relations, Harold V. Coes, D. Robert Yarnall, and Robert I. Rees.

BOARD OF EDITORS OF JOURNAL OF APPLIED MECHANICS

Upon recommendation of the Applied Mechanics Division, endorsed by the Committee on Publications, it was voted to appoint the following Board of Editors for the *Journal of Applied Mechanics:* J. M. Lessells, Swarthmore, Pa., technical editor; R. Eksergian, Budd Mfg. Co., Philadelphia, Pa., electromechanics; J. Goff, University of Illinois, Urbana, Ill., thermodynamics; J. C. Hunsaker, Massachusetts Institute of Technology, Cambridge, Mass.; J. P. Den Hartog, Harvard University, Cambridge, Mass., vibration; T. von Kármán, California Institute of Technology, Pasadena, Calif., aerodynamics; G. B. Karelitz, Columbia University, New York, N. Y., lubrication; F. M. Lewis, Webb Institute of Naval Architects, New York, N. Y., ex officio; A. Nadai, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa., plasticity; B. L. Newkirk, General Electric Co., Schenectady, N. Y.; A. I. Lipetz, American Locomotive Co., Schenectady, N. Y.; J. Ormondroyd, Westinghouse Electric and Manufacturing Co., South Philadelphia, Pa.; R. E. Peterson, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa., strength of materials; S. Timoshenko, University of Michigan, Ann Arbor, Mich., elasticity.

MEMBERSHIP

Upon recommendation of the Board of Review it was voted to approve certain requests regarding suspension, dropping, and loss of seniority, and to disapprove certain others. It was further voted to extend for one year the period of time within which junior members who became 35 years of age during the fiscal year 1933–1934 may make applications for a higher grade of membership; to extend for one year the rate of dues of ten dollars to juniors who have been in that grade six years; to approve the recommendation that junior members who are placed on a suspended list and who apply for return to active status in 1935 or 1936 be entitled to receive the rate of ten dollars per year for six years, the years in which they are inactive not being considered as years of membership in the Society unless the member has reached the age of 35 on the application to return to active membership; to approve the recommendation that junior members who accepted loss of seniority as of October, 1933, be allowed six years of membership at the rate of ten dollars from that date unless they reach the age of 35 years before the six-year period expires, in which case they must apply for transfer in accordance with Article C4, Section 6, of the Constitution and By-Laws.

It was further voted to rescind previous action establishing the date for return to membership after loss of seniority as of October 1, 1933, and to establish the rule that in figuring the loss of seniority only the period for which the member has not paid dues is to be considered.

It was voted to extend the time in which 1934 graduates may pay initiation fee and first-year dues from January 1, 1935, to June 30, 1935. The Committees on Relations With Colleges and Membership were requested to review the procedure by which student members become junior members and make recommendations concerning it.

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

It was voted to designate an unofficial observer on the Advisory Council of the National Society of Professional Engineers.

THERMAL PROPERTIES OF STEAM

The resignation of Alex Dow as chairman of the Committee on the Thermal Properties of Steam was accepted with regret and with sincere appreciation of the value of his contribution to the work of the research program of the Committee.

APPOINTMENTS

The following appointments were approved: Addition to Committee on George Westinghouse Bust, L. A. Osborn, and Karl T. Compton; Chairman of the Board of Technology, Dean A. A. Potter; Chairman of the Board on Standards and Codes, Alex D. Bailey; Additional Members on Committee on Policies and Budget, James N. Landis, and Alfred Iddles; Advisory Committee to Group 4, Publications, of the Code Authority of the Periodical Publishing and Printing Industry, C. E. Davies; Representative of the Society on the American Year Book Corporation, C. E. Davies.

UNWIN MEMORIAL

It was voted to participate in the committee to develop a permanent memorial to William Cawthorne Unwin, honorary member, A.S.M.E.

PARTICIPATION BY JUNIORS

It was voted to appoint a committee consisting of A. A. Potter, D. B. Prentice, W. A. Hanley, W. H. Winterrowd, and a junior member to be selected by this group to develop a program for the participation of junior members in the activities of the Society.

Harry Harrison New President of A.S.R.E.

THIRTY years of progress, from the period of the first artificial ice to the present day of universal refrigeration and widespread air-conditioning, were surveyed at the meetings of the American Society of Refrigerating Engineers, who met on December 5, 1934, in New York, for a three-day session celebrating their thirtieth anniversary.

The new president of the society, elected at this meeting, is Harry Harrison, of the Philadelphia office of the Carrier-Engineering Corporation.

Providence Engineering Society Dedicates New Home

THE fortieth anniversary of the founding of the Providence Association of Mechanical Engineers, the forerunner of the present Providence Engineering Society, was marked by the formal dedication on Thursday evening, November 29, of the society's new home, a debt-free building, at 195 Angell St., Providence, R. I.

The building, itself, is a two-story brick structure of fireproof design. The first floor consists of offices from the rent of which an income sufficient to cover operating and certain other expenses will be derived. The society has its quarters on the second floor, where besides the library is an auditorium capable of seating 300 people. The means by which the Providence Engineering Society financed the original purchase of this building is described in the August, 1934, issue of MECHANICAL ENGINEERING, p. 511.

In the library on a brass plate below the mantle is inscribed the following: " 'Each man is debtor to his profession,' therefore it seems fitting that when one's profession has given lifelong happiness and a competence he give token of appreciation of his indebtedness to those who have gone before and give friendly encouragement to those coming along." The initials "J. R. F." are appended to the inscription.

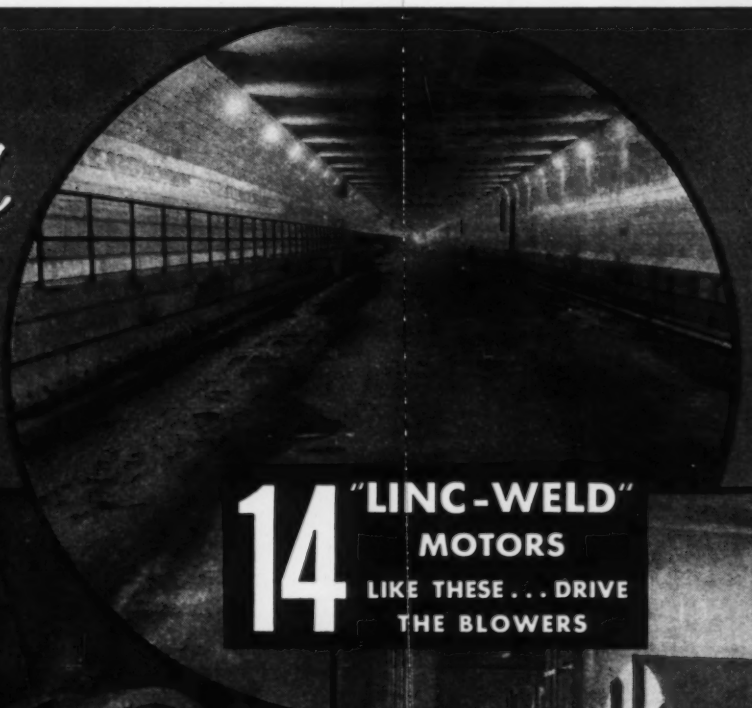
Three hundred members and their guests at the exercises greeted with hearty applause the announcement by Clarke Freeman, a member of the Society's Council, and son of the late John R. Freeman, that the building and its furnishings were entirely free of debt. This was made possible through the generosity of the Freeman family, who besides paying off the mortgage and all outstanding bills, donated the library, its luxurious furnishings, and six shelves of books from Mr. Freeman's personal collection of technical works. Mr. Freeman was both an honorary member and past-president of the society.

Ernest F. Walsh, president of the Providence Engineering Society, acknowledged the gift in behalf of the society and with the deepest appreciation, adding "It is the desire of your officers to present to the society, meetings during the year that will be of interest to the membership at large. These meetings have been and will continue to be varied in character, and we want them to be of the greatest possible value to you and to the civic life of the community."

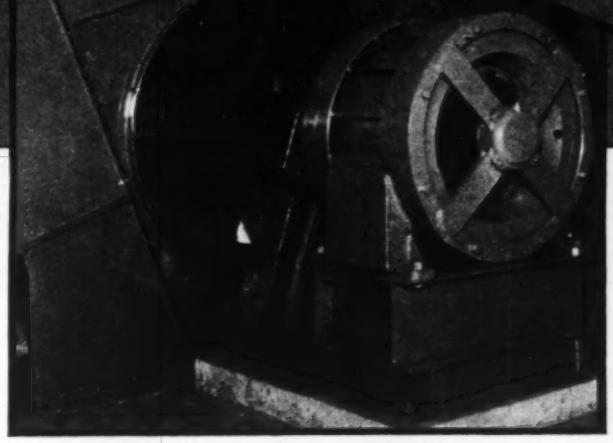
Speakers at the exercises which followed included Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, Robert W. Adams, first president of the society in 1894, Frank Winsor, past-president of the society, and Clarke Freeman.

Mr. Adams' talk was an informal one with many anecdotes of past-presidents of the society; Mr. Winsor discussed the activities of the society; while Dr. Compton, in discussing engineering generally, spoke of the efforts of M.I.T. "to turn out young men who will work in and develop the engineering profession."

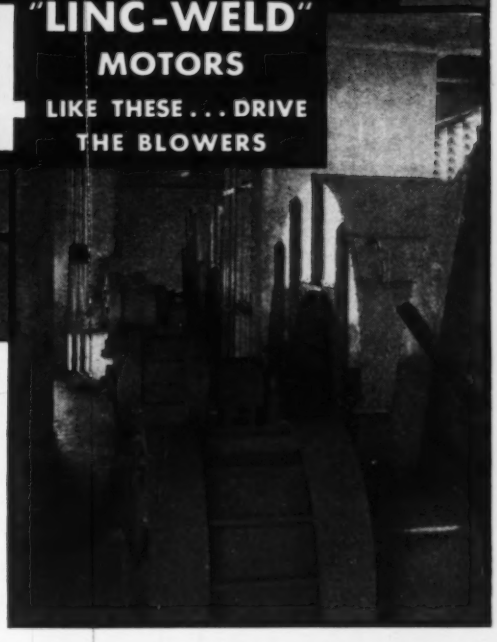
Fresh Air here



14 "LINC-WELD" MOTORS LIKE THIS . . . DRIVE EXHAUST FANS



14 "LINC-WELD" MOTORS LIKE THESE . . . DRIVE THE BLOWERS



in Boston-East Boston Vehicular Tube

Again, where human lives are at stake, "Linc-Weld" motors are placed on the job. The two latest underwater vehicular tunnels to be completed—first the Geo. A. Posey tube between Oakland and Alameda, Calif., and now the world's largest, the Boston-East Boston tube—depend on "Linc-Weld" motors to keep the air fresh and remove all danger of asphyxiation. Twenty-eight "Linc-Weld" two-speed squirrel cage type motors drive the fans and blowers which handle as high as two million cubic feet of air per minute, changing all the air in this newest tube 40 times every hour.

To meet specification demands for extra high efficiency and power factor required only Lincoln's usual standards of design, materials and construction as applied to all types of "Linc-Weld" motors. Thus you, too, can obtain dependability plus improved operating characteristics of "Linc-Weld" motors for your equipment.

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M-14

Cornell to Give Courses in Large-Scale Planning

CORNELL University is to give courses in large-scale planning, starting February 1, 1935, under the direction of Gilmore D. Clarke, well-known consultant, who for many years was engaged on the planning problems of Westchester County as landscape architect for the Park Commission. He is also a consultant on many important large-scale developments throughout the country and is a member of advisory boards at Cornell, Harvard, and Massachusetts Institute of Technology.

The proposed courses are being sponsored jointly by the Colleges of Engineering and Architecture, although registration will be on a purely voluntary basis, and it is expected that the work will cut across college lines in all directions.

While the work in regional planning is not to be of a technical character, it will inevitably make itself felt in the technical work of at least three colleges. In the College of Architecture the faculties of Architecture and Landscape Architecture will be strengthened by the presence of a man of wide experience in park, parkway, and planning problems. In the College of Engineering, and especially in the department of Highway Engineering, these courses will tend to place greater emphasis on the social and aesthetic aspects of highway and parkway problems. In the College of Agriculture, where already much work has been done on the problems of land use and rural social organization, the effects of collaboration in a related field will be especially helpful.

A.S.M.E.—A.S.C.E. to Hold Joint Hydraulic Meeting

AS a result of the policy of cooperation between the Hydraulic Division of the A.S.M.E. and the Power Division of the A.S.C.E., a joint program has been arranged in connection with the annual convention of the A.S.C.E. The program has been prepared jointly by a special committee consisting of Ford Kurtz, secretary of the Power Division of the A.S.C.E., and S. Logan Kerr, secretary of the executive committee of the Hydraulic Division, A.S.M.E. The morning session will be devoted to papers sponsored by the A.S.M.E. dealing with the mechanics of fluid flow and water measurement. The afternoon session, which will be sponsored by the A.S.C.E., will deal with engineering features of the TVA projects.

The program in detail is as follows:

Thursday Morning, Jan. 17, 1935

9:30 a.m. *A.S.M.E. Session*

Presiding Officer: Dr. Wm. M. White, manager and chief engineer, hydraulic department, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

The Bentzel Velocity Tube, by F. H. Falkner, first lieutenant, Corps of Engineers, Director, U. S. Waterways Experiment Station, Vicksburg, Miss.

Pitot-Tube Practise, by Edward S. Cole, president, The Pitometer Company, New York, N. Y.

Forty Years of Comparative Measurements by a Venturi Meter and Ten-Foot Weir, by Dr. C. M. Allen, professor of hydraulic engineering, and L. J. Hooper, Worcester Polytechnic Institute, Worcester, Mass.

12:30 p.m. *Joint Luncheon*

(A.S.C.E. Power Division and A.S.M.E. Hydraulic Division at the Engineers' Club)

Thursday Afternoon, Jan. 17, 1935

2:30 p.m. *A.S.C.E. Session*

Presiding Officer: J. C. Stevens, chairman, Power Division, A.S.C.E., Stevens & Koon, Portland, Ore.

Engineering Design Features of Norris Dam and Power House, by Barton M. Jones, Construction Engineer, Norris Dam, TVA.

Engineering Design Features of Wheeler Dam and Power House, by W. M. Hall, construction engineer, Wheeler Dam, TVA.

The Regulation of the Tennessee River, by James S. Bowman, hydraulic engineer, TVA.

E.C.P.D. Prepares to Accredit Engineering Curricula

AT ITS annual meeting on October 23, 1934, the Engineers' Council for Professional Development adopted a procedure for accrediting engineering curricula reported by its Committee on Engineering Schools.

During the past year the committee engaged in two general activities: (1) The revision of a questionnaire to be used in the E.C.P.D.'s program of accrediting the curricula of engineering schools, and (2) the study and recommendation of a method of procedure and form of organization for carrying out the actual work of such accrediting. It recommended that the operating organization in the accrediting process be the E.C.P.D.'s Committee on Engineering Schools and that the inspection of schools under the procedure be performed by subcommittees, designated as "delegatory committees," to be composed of competent individuals nominated by this committee. Each of these delegatory committees is to consist of five members and is to serve one of seven geographical regions. The program is to commence with the accrediting of schools in the northeastern region.

The program of accrediting involves two procedures, (1) the filling out by officers of the school of a "questionnaire" covering factual information on the curricula to be accredited and on the school and faculty involved, and (2) an inspection by the delegatory committee. The delegatory committee will report to the Committee on Engineering Schools, which, in turn, will report to the E.C.P.D. for action. The expense of visits of inspection will be met by standardized charges against the schools whose curricula are involved.

The following societies have approved the E.C.P.D. as the accrediting agency for engineering schools: A.S.M.E., Am.Soc.C.E., A.I.M.E., S.P.E.E., and the N.C.S.B.E.E. The A.I.E.E. gave its approval with the reservation that its Board of Directors would wish to approve the plan when developed, and that there be no request to the A.I.E.E. for funds. Special arrangements for accrediting curricula in chemical engineering have been arranged with the A.I.Ch.E.

The personnel of the E.C.P.D. Committee on Engineering Schools is as follows: Karl T. Compton, chairman, E. P. Mathewson, H. S. Rogers, H. A. Curtis, A. A. Potter, P. H. Daggett, and H. P. Hammond.

Leipzig Trade Fair, March 3 to 10, 1935

THE Leipzig Trade Fair (Leipzig, Germany) will be held March 3 to 10, 1935. This great international market is the oldest going concern in the world, having been held for a period in excess of 700 years. More than 8000 exhibits will be contributed by a score of the leading countries including the United States. A special effort is being made this year to extend international trade relations.

Apply Now for Proceedings of 4th International Congress for Applied Mechanics

THE Proceedings of the Fourth International Congress for Applied Mechanics, held in Cambridge, England, July, 1934, are about ready for press, and those desiring to purchase copies at the price of £1 are requested to notify the organizing secretary, Engineering Laboratory, Cambridge, England, immediately, so that an adequate number of copies may be printed. The volume will contain the seven general lectures printed *in extenso*, abstracts of about 140 sectional papers, and other data relating to the Congress.

A Correction

IT IS presumed that readers of MECHANICAL ENGINEERING were more alert than we were and recognized the fact that the captions of the charts in Mr. Harrison's paper in the December issue (pages 739 and 740) had been interchanged.

This Month's Authors

D. S. KIMBALL, dean, College of Engineering, Cornell University, and past-president, A.S.M.E., Towne Lecturer for 1934 on the relation of engineering and economics, draws upon his own wisdom and that of the ancients in his critique of prophets and panaceas. Years of intimate association with men in industrial and educational pursuits have seasoned his opinions and clarified his understanding of human problems.

Messrs. Hopkins and Nelson are two junior members of the A.S.M.E., resident in New York, to whom the Committee on the Capital-

ROEBLING *Requires* RELIABILITY

JOHN A. ROEBLING'S SONS CO. wire rope manufacturers and suspension bridge builders, of Trenton, N. J., has always believed in and practiced the rule that only the best is good enough.

The Brooklyn Bridge, built several generations ago, still carries a load considerably greater than that for which it was originally designed.

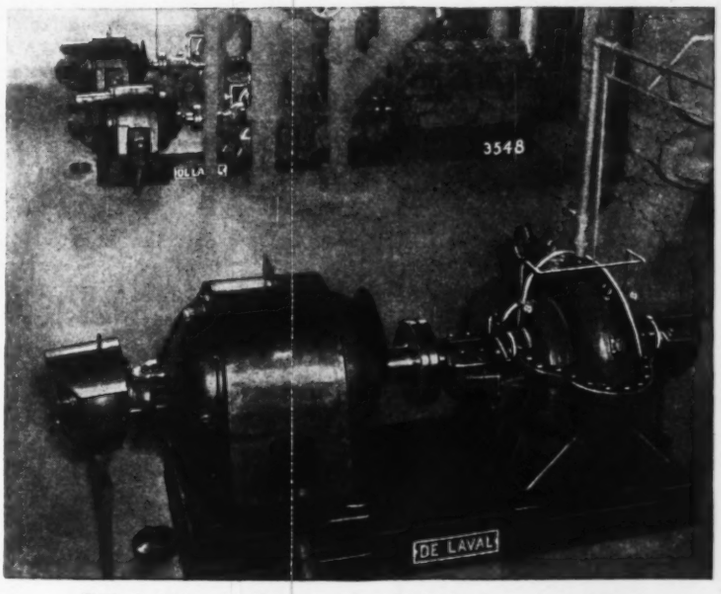
Likewise, the Roebling power plant is equipped only with machinery that can be depended upon.

For fire protection there are two DE LAVAL centrifugal pumping units, each arranged to be driven by either electric motor or gasoline engine.

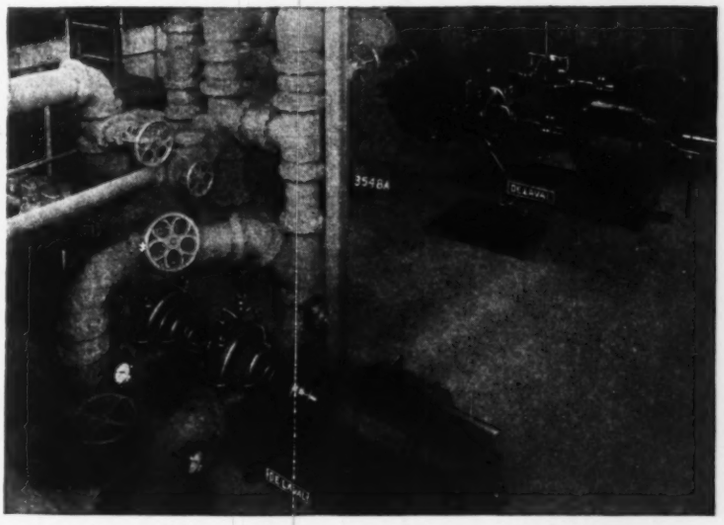
General water service is provided by DE LAVAL motor driven pumps of high efficiency.

All DE LAVAL pumps are protected at points subject to wear by renewable wearing parts, such as shaft sleeves and impeller and casing wearing rings, and are built to limit gages on an interchangeable basis so that replacements can be made by unskilled men. Efficiencies and other characteristics are guaranteed and demonstrated by test.

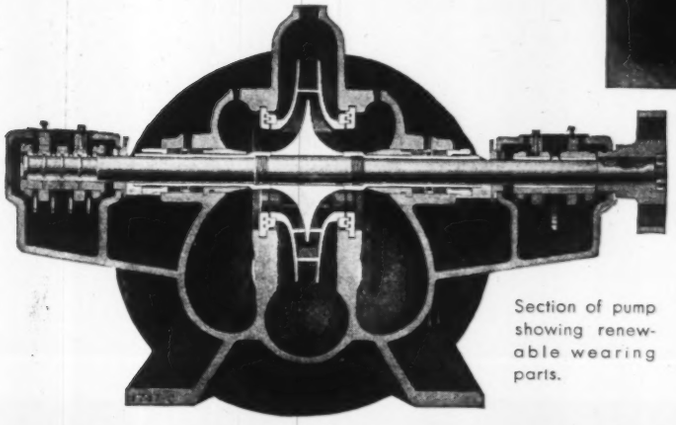
Ask for Catalog B



● One of the two service pumps; 8400 g.p.m. each against 127 ft. head at 900 r.p.m., with 84% efficiency. Two dual driven fire pumps in background.



● One of the two fire pumps; 1500 g.p.m. each against 304 ft. head at 1150 r.p.m.; also two service pumps and, in extreme background a low head pump rated at 3500 g.p.m. against 40 ft. at 1150 r.p.m.



Section of pump showing renewable wearing parts.

DE LAVAL
STEAM TURBINE CO.
Trenton, New Jersey

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